POWER

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Spares

MANY an expensive shutdown with loss of wages to the help and loss of profits to the mill has been avoided by the thoughtfulness of an engineer who had a spare part ready when something gave out.

It is true that duplicate parts cost money and run up the overhead.

They are likely to lie around for the lifetime of the apparatus and have no opportunity to justify their purchase.

They are likely to have been around so long and stowed away so carefully that when they are needed, nobody knows where they are or even *that* they are.

A system that will keep them in condition for immediate use through years of waiting, that will keep knowledge of them at somebody's fingers' ends with shifting personnel and changing management, may be difficult and expensive to maintain.

But one good shutdown prevented will justify it all.

If one only knew what was going to give out and when, it would be simple. The fact that it is not known and that so much depends upon it gives an opportunity for the exercise of real judgment as to what is most likely to happen and how soon one must be ready for it.

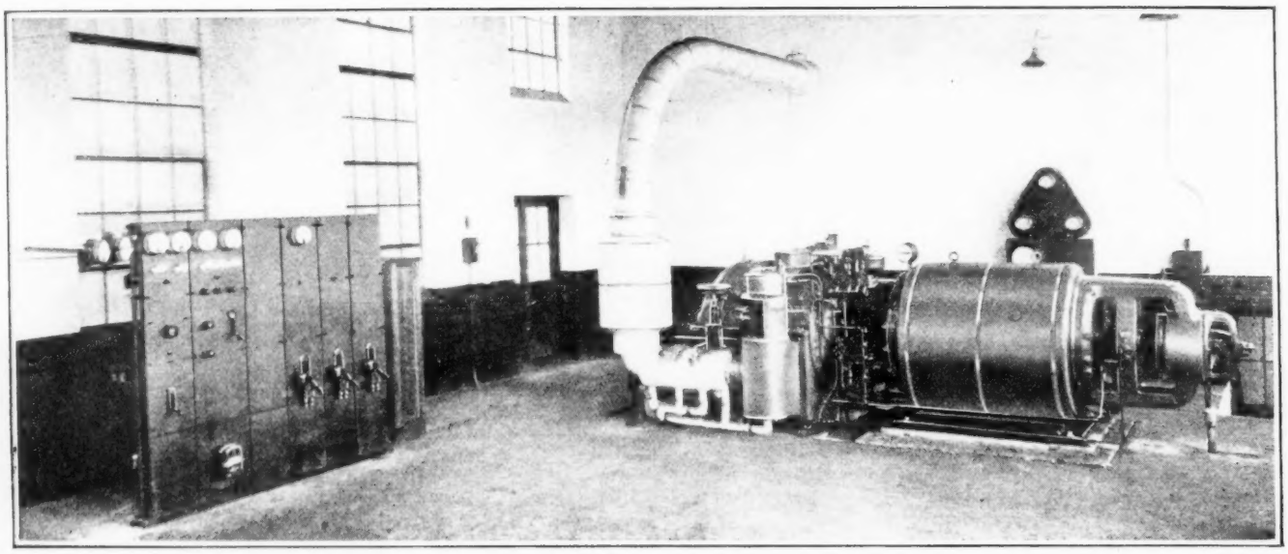
The greater ease with which major repairs can be made on the spot with modern welding and flame cutting methods, the greater number and accessibility of well-organized machine shops, the better transportation facilities of today, all minimize the importance of carrying heavy special spares; and the better distribution of parts and service stations for standard apparatus makes the carrying of such a multiplicity of small plants unnecessary.

Some mental review of the possibilities, some thought as to the really significant pieces, the strategic points that specially need guarding, will often indicate the essentials and eliminate the inadvisable.

The smaller appliances are not so vital to the continuance of operation, but it costs less to keep duplicates of the parts that are most likely to fail. The selection of these parts should be left to the man who has charge of their operation and who knows what is most likely to give out and what is most important to be able to replace.

Manufacturers of such appliances, far from seeking to profit by the sale of unnecessary parts, deplore the tendency to purchase spares, repairs and replacement parts in excess of actual requirements. The costs are charged to the maintenance of the apparatus and if unnecessarily heavy react to the prejudice of its performance and endurance record.

F. R. Low



1,000-kw. extraction turbine at Proximity Mills

Extracted Steam Solves Power Problem

The Proximity Manufacturing Co., Denim Cloth Manufacturer, by Installing an Extraction Turbine and High-Pressure Boilers Makes Remarkable Power Cost Reduction—Steam at 15 Lb. Bled to Supply Dye House—Boilers Operate at 200 Lb. and with 100 Deg. Superheat

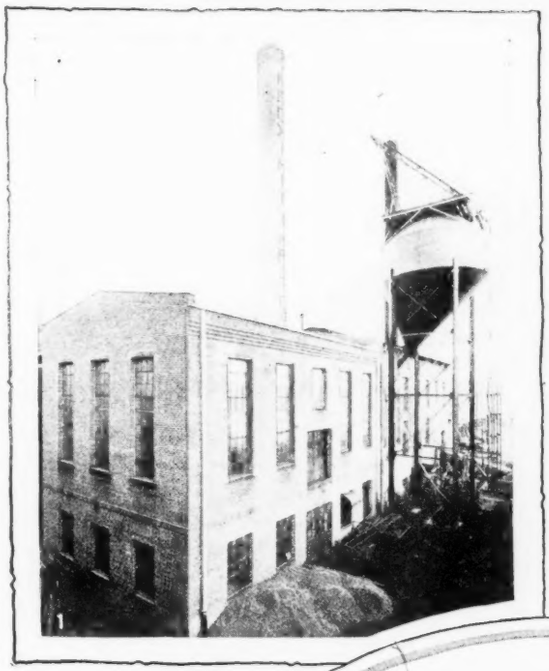
LIKE many other textile plants, the Proximity Mills, Greensboro, N. C., which have 1,600 looms and 55,000 spindles, have found that the cost of power and heat can be reduced through the use of an extraction turbine. Formerly these mills had five small hand-fired horizontal water-tube boilers operating at 150 lb. pressure, and live steam was used in the dye vats and in the slashers. Power was obtained from the White Oak Mills, owned by the same interests and located about two miles distant. All of the plant motors were three phase, 550 volts, 40 cycles. The White Oak Mills have reciprocating compound Corliss engines, but obtained secondary power from a transmission line.

In an attempt to reduce the steam and power costs, it was decided to abandon high-pressure steam for process work, and install a prime mover exhausting at a pressure such as to make the exhaust steam feasible in the dye house, etc. Inasmuch as the dye house and slashers do not always require the amount of steam that would pass through an engine or turbine of the capacity needed for the other departments, an extraction type turbine proved to be the most suitable for the required service. The plant load is approximately 900 kw., and to provide an overload capacity, a 1,000-kw. 3,600-r.p.m. Curtis-type, three-stage extraction machine was installed. The generator is a three-phase, 60-cycle, 550-volt unit, with a direct-connected exciter. It was necessary to replace with 60-cycle motors the 40-cycle motors in those parts of the mills to be carried by the turbine.

The turbine is arranged to bleed at 15 lb. and has the outputs and steam consumptions while bleeding various amounts of steam as shown by the curves in Fig. 7. The lower curve gives the steam consumption at various loads when operating straight condensing with the extracting device entirely eliminated; the second curve gives the consumptions when the grids are on but wide open, and with no steam being extracted. The other curves cover the operation when extracting various amounts of steam per hour. For example, at an electrical load of 800 kw., the total steam consumption is 31,000 lb. per hour, when 30,000 lb. is being extracted at 15 lb. gage. With 1,000 kw., the consumption is 33,800 lb. if 30,000 lb. is being extracted; whereas the consumption at the same load is only 23,100 lb. if only 10,000 lb. is being extracted.

The turbine is located in a new building, in which space has been left for a 1,500-kw. unit, to be installed in the future in order to permit the power plant to carry all of the mill load. At present additional power is being obtained from the White Oak Mills to operate the 40-cycle motors still remaining in some of the buildings. In the turbine room is placed a six-panel switchboard, consisting of three feeder panels, one generator panel, one exciter panel and one panel left blank to be connected to the 1,500-kw. unit when it is installed.

In the turbine-room basement are located the condenser, hot-well pump, condensing-water pump and the oil switches for the switchboard. The surface condenser



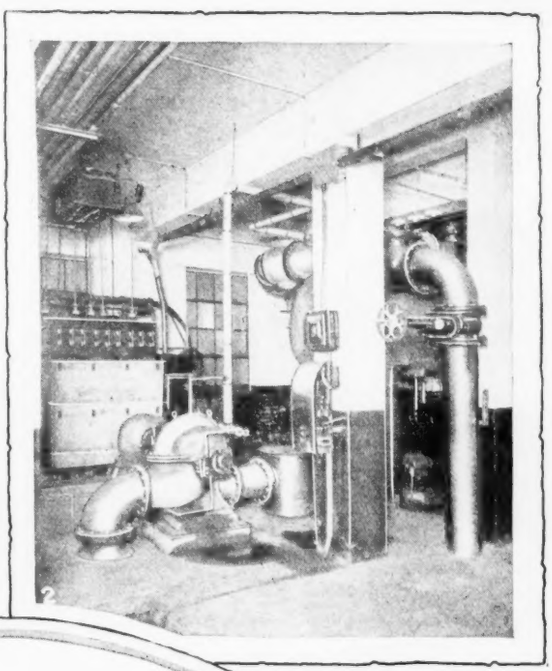


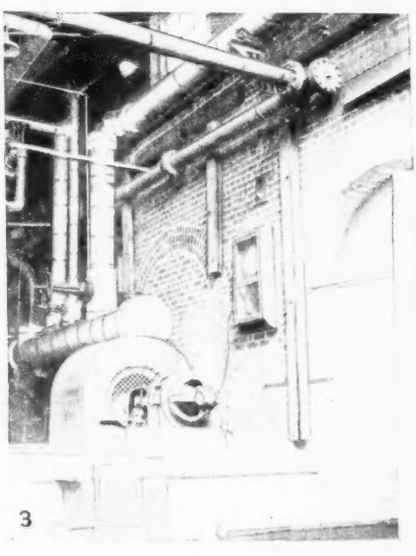
Fig. 1—New power plant with turbine room in the foreground

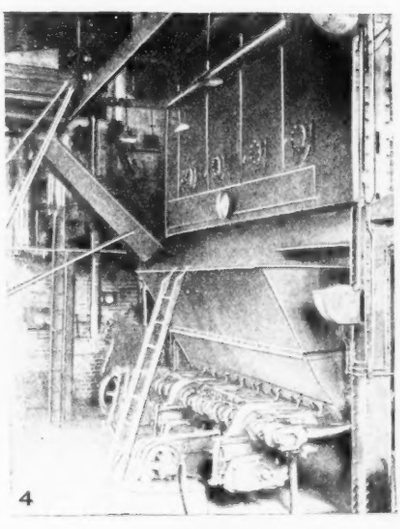
Fig. 2—The condenser and circulating-water pump are in the basement

Fig. 3—Draft fan and steam main at rear of boiler

Fig. 4—The boiler is stoker fired

Fig. 5—Ashes are dumped into an elevated hopper





has 2,550 sq.ft. of tube surface. The air pump is of the radiojet type in duplicate, and is provided with inter- and after-condensers.

To supply steam to the turbine, three of the five old water-tube boilers were removed and a 7,790-sq.ft. inclined-tube boiler installed. This unit is built for 250-lb. working pressure (although 200 lb. is normally carried), and is provided with a superheater to give 100 deg. of superheat.

A nine-retort underfeed stoker is used. Either a vertical high-speed engine, or a chain-drive 1,200-r.p.m. motor, as desired, may be used for driving this

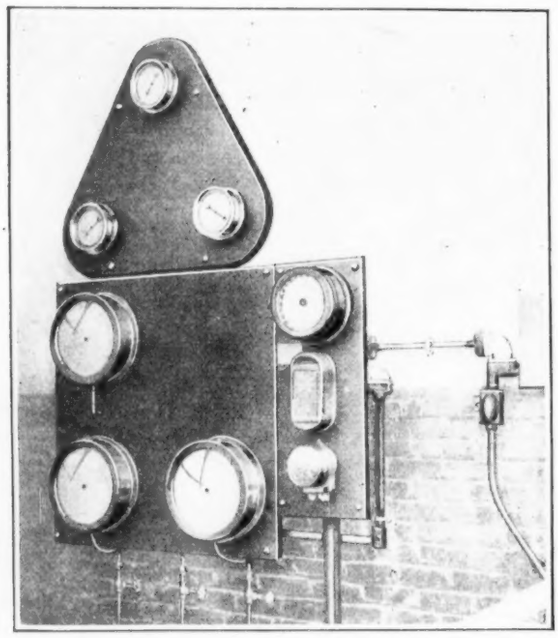


Fig. 6—Instrument board in turbine room

stoker. With Pocahontas mixed slack and nut coal, the combined boiler and furnace efficiency was guaranteed by the stoker manufacturer not to be lower than the following:

Load, Per Cent of Rating	Combined Efficiency, Per Cent
100	77
150	79
200	77

It is not deemed desirable in cotton mills to exceed 200 per cent rating, since the load is fairly constant and not subjected to the peaks that in central stations require high outputs for short periods. No special furnace construction is used. The walls are laid up of high-grade firebrick, bedded in a high-heat special fireclay.

The condensate from the turbine condenser and the returns from the heating system and slashers are all returned to an open heater, located between the boiler and the turbine-room wall. The average return-water temperature is 150 deg. F. The heater is fitted with a V-notch meter to permit accurate recording of the boiler feed. Makeup, which is taken from the general water supply, is approximately 10 per cent of the total boiler feed, being that required to offset the steam passing out the perforated pipe coils in the dye vats, plus the ordinary leakage. All of the drips from the turbine, air-pump after condenser, pipe lines, etc., are passed through traps to the heater. The steam for feed-water heating is bled from the 15-lb. extraction steam line through a thermostatically controlled valve, the relief valve on the heater being set to blow at 15 lb. to prevent overpressure.

Coal is unloaded from a trestle and is elevated by a skip hoist to the steel bunker shown in Fig. 1. A chute passing through the boiler wall conveys the fuel to the stoker hopper. The cinders from the stokers drop into an ash hopper and are then dumped into a narrow-gage lorry in the basement and are hauled out and elevated into the tile cinder hopper, as shown in Fig. 5.

As has been outlined, the mills' steam requirements are met by the extraction of steam at 15 lb. gage pressure. There is, however, a live-steam connection to meet any deficiency in the extraction supply. A reducing valve of the balanced type is connected to a diaphragm-operated beam regulator. At a drop in the steam-line pressure from 15 to 14 lb., the regulator opens the reducing valve to admit live steam, the pressure being lowered by the valve to 15 lb. A second reducing valve is used on the line to the raw-stock driers. These driers require 60-lb. steam, and this is

PRINCIPAL EQUIPMENT

Turbine:	
Capacity, kw	1,000
Type	Extraction
Make	General Electric Co.
Exciter	Direct connected
Switchboard	Westinghouse Electric & Manufacturing Co.
Condenser:	
Type	Surface
Make	C.H. Wheeler Manufacturing Co.
Tube surface, sq.ft.	2,550
Tubes, diameter and gage	¾ in.; 18 gage
Air Pump:	
Type	Duplicate Radiojet
Hot-Well Pump:	
Type	Centrifugal
Size, in.	1½
Rpm.	1,800
Drive	5-hp. General Electric motor
Circulating Pump:	
Type	Centrifugal
Size, in.	10
Capacity, g.p.m.	2,310
Rpm.	1,200
Drive	40-hp. General Electric motor
Make	C.H. Wheeler Manufacturing Co.
Boiler:	
Type	Class 13 Stirling
Make	Babcock and Wilcox
Heating surface, sq.in.	7,790
Superheater, make	B & W
Steam pressure, lb. gage	250
Superheat, deg. F.	100
Stoker:	
Type	9-retort underfeed
Make	Riley Stoker Corp.
Drive	5x6 in Sturtevant engine; 7½ hp. General Electric motor
Forced Draft Fan:	
Make	American Blower Co.
Capacity, cu.ft. per minute	25,000
Dis. pressure	5-in. water
Drive	40-hp. G. E. variable-speed motor
Soot blowers	Diamond Power Specialty Co.
Blow-off valves	Yarnall-Waring Co.
Damper regulator	(Craig) A. W. Cash Co.
Feed-water regulator	(Copes) Northern Equipment Co.
Heater:	
Type	Open
Make	Warren-Webster
Heater control valve	Fulton Co.
Boiler-Feed Pump:	
Type	5-stage centrifugal
Size, in.	4
Capacity, gal. per minute	170
Rpm.	1,780
Drive	50-hp. General Electric motor
Make	Morris Machine Works
Fire-brick	Harbison-Walker
Fire-clay	Keystone Refractories Co.
Ash hopper	Allen-Sherman-Hoff
Coal bunker	R. D. Cole
Coal and ash hoist, etc.	Link-Belt Co.
Chimney:	
Size	175x9 ft. at top
Type	Radial brick
Make	M. W. Kellogg Co.
Piping	Grinnell Co
Pipe covering	General Equipment Co.
Live steam-reducing valve	Fisher Governor Co.
Pressure regulator	Spencer Regulator Co.
Steam-flow meter	General Electric Co.
Recording steam gage; Recording pyrometer	Brown Instrument Co.
Non-return valve	Lunkenheimer Co.
Steam traps	V. D. Anderson Co.
Steam and water valves	Chapman Valve Co., and Lunkenheimer Co.

taken from the boiler steam main through the reducing valve.

The turbine operates extracting for five days of the week, during which time the 15-lb. steam is needed. On Saturday the dye house is not in operation and the turbine is run straight condensing.

The plant is supplied with steam-flow meters, recording pressure gages, and a flue-gas temperature-recording pyrometer, as well as a feed-water meter and the usual dial steam and vacuum gages.

Large Coal Saving Effected

Data as to the cost at present compared with that of former operation of the boiler and with the electrical energy purchased cannot be obtained from the management. However, the first month after the new plant went into operation 104 tons less coal was used than was needed to supply live steam to the processes during the corresponding month of the previous year, the mills' output being almost identical during these two months. Most of this coal saving is traceable to the better efficiency of the stokered boiler compared with that of the old hand-fired boilers. Some advantage also may lie in the use of wet steam in place of the live steam slightly superheated by passing a reducing valve. The net result is that the mill obtains about 180,000 kw.-hr. per month and as much process steam as heretofore used at a fuel cost that is less than the cost of the coal formerly needed for process steam only, and the expense of purchased power is eliminated. The total investment is approximately $176 per kilowatt.

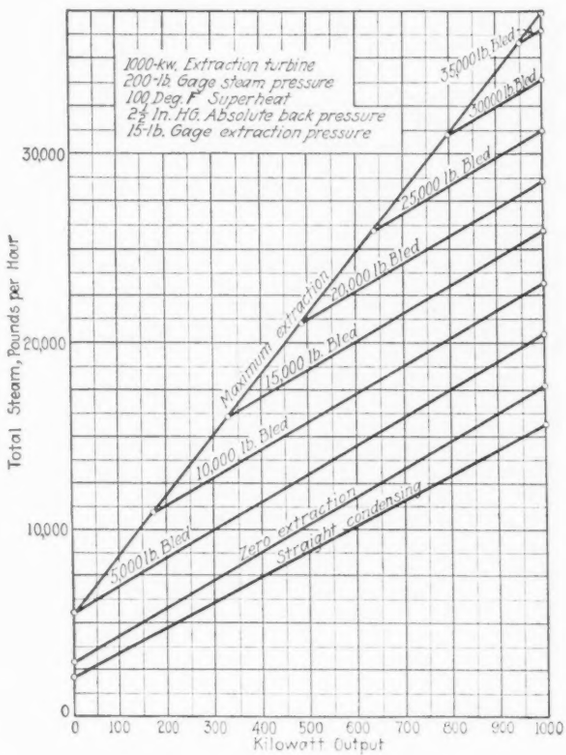


Fig. 7—Steam consumption of turbine with extraction operation

The equipment was in the main installed by the machinery manufacturers, the mills supplying the common labor. J. E. Sirrine & Co., Greenville, S. C., were the consulting engineers.

The Joys of Operating a Stand-by Plant—II*

By "The Chief"

WITH a stand-by plant there are long periods when we don't turn a wheel. It is a case of everything going out and nothing coming in—the old mill stands here eating her head off. We have to keep men enough to be available when the call comes, have to burn coal to keep steam mains hot and (in the cold weather) to keep warm and take care of the fire pumps, etc. In trying to hold down expenses to a minimum we do work for other departments when we can.

One job we recently had was building a driveway into one of the company properties near by. I should hate to have to pay for that driveway out of my own pocket; not that we loafed on the job, but with engineers, oilers, stoker operators, etc., getting twice the pay of laborers and being unused to that kind of work (the heaviest work they had done in years was to push an oil can or open a throttle valve or something no harder), the cost was bound to be high. We finished the driveway and nearly finished the crew. I have stayed away from the fellow for whom we did the job until he forgets about the cost.

There are several other buildings where we occasionally do steam fitting, which is more in our line. We also grab all the electrical jobs we can; these also are in our line. But the blacksmith was our bread and butter for a long time. He could work harder and do less in more time than any one I ever saw, and needed two or three helpers.

In these other buildings are heating boilers that we have maintained for a number of years. What a cussed nuisance they were, always needing grate bars or overhauling, tubes rolled or bored, valves ground or some other old thing every few weeks, and always when we were busiest. How different now—we love those little boilers like a baby loves its bottle, or a laddie loves his lassie. The calls can't come too often; in fact, we anticipate them. Never were any boilers inspected and put in order so thoroughly or so often as these.

One afternoon while we were working on the driveway it got quite dark early and I had a hunch that we might be needed. You fellows that have ever played the ponies know how hard it is not to play a hunch when you have one; so we knocked off and went back to the station. The old hunch worked—by the time the boys had washed up the sun-up gun was fired, and we were off—not very strong, but enough for one boiler, and it kept us on the map at least.

In bringing the turbine up the engineer was a bit fast and it came up rather rough. We didn't want to stop and start over again, so up she came and went on the line, getting rougher all the time. Another turbine was brought up and cut in, but by the time this was done the first one was doing a Charleston that could beat any guy that ever shook a hot foot. Well, we cut her out and looked things over—tried her again and she came up as smooth as the dominie when he is looking for an extra large offering. At 5 o'clock the load dropped and so did we.

(To be continued.)

*The first installment appeared in the March 16 issue.

Dispelling Some Ammonia Condenser Fallacies

Disadvantage of Flooded Systems—Liquid Should Be Removed from Condensing Surfaces—Shell-and-Tube Design Maintains Constant Water Velocity

By H. J. MACINTIRE

FREQUENTLY refrigerating engineers raise the question as to what form of ammonia condenser is the best. Is the best condenser the common atmospheric or the drip type, or is the submerged, the double pipe or the shell-and-tube condenser the best, and why? Others ask as to the advantage of bleeding off the condensate in the case of the drip type condenser, and why the old top feed type is not the better of the two.

In the design of refrigerating equipment the first thought of the engineer has been safety. As regards condensers, he thought that the flanged joint could be made tight and perfectly safe. As time passed and electric welding was found to be dependable, he developed coils, and the submerged condenser was the result. However, the submerged condenser was not found to be efficient, and it was abandoned in favor of other designs.

New Designs

As fittings were perfected, horizontal coil condensers were developed with the water dripping from pipe to pipe, these being the atmospheric when the water flowed down over the coils and the double-pipe condensers, with the water passing through the inner pipe. In all of these designs the ammonia is pumped through a continuous pipe, the cross-section of which remains practically constant, and heat is absorbed by the cooling water until finally all the ammonia is liquefied.

The shell-and-coil condenser was the only distinctive design up to, say, 1915, for in this case the ammonia went into the shell in which were placed the water-cooling coils and the water velocity could be controlled to some extent. The shell-and-tube design of condenser has been developed lately, being similar to the steam condenser of the surface type. This ammonia condenser has been made possible through the action of the steel mills in manufacturing lap-welded pipe up to 96-in. diameter, and through the perfection of welding. However, riveted and welded shell-and-tube condensers are still advocated and built by some firms.

Refrigeration design has been retarded by certain erroneous ideas, one of these concerning the action of liquefied ammonia on the condensing surfaces. Because of the publicity given to the flooded type of condenser, it has been generally understood that a great advantage resulted in thoroughly mixing the compressed gas from the compressor with liquid ammonia and sending the mixture through the condenser tubes. This idea is entirely wrong. As a rule the superheat in the ammonia, even when the condenser is close to the compressor, will disappear after passing through two or three pipes, corresponding to 40 to 60 linear feet of pipe. From this point on, condensation takes place to a greater or lesser extent, and the surfaces are wet. It is generally understood that wet surfaces are more efficient in heat transfer than those that are exposed to superheated vapors, but when the vapor is liquefied, it must be removed immediately. It has been found, especially in steam condensers, that heat transfer from the metal walls to liquids more or less stagnant is relatively small, and the velocity of the gas as well as the liquid in the usual ammonia condenser is very nominal. In this connection it is worth while considering the velocity existing in the 2-in. condenser rated at about 12 to 15 tons. The volume of 6.0 lb. of ammonia gas, dry and saturated at 150 lb. gage pressure, is $6.0 \times 1.82 = 10.92$ cu.ft., and if this is pumped into the condenser every minute, the velocity at the point where superheat disappears is 468 ft. per minute, or less than 8 ft. per second. Such a velocity would not cause ripples on the surface of any liquid in the pipes. It is quite possible, however, to have the pipe so full of liquid, as in the flooded condenser, that this velocity is increased five or ten times, in which case the heat transfer will be enhanced, probably at the expense of the excess pressure developed by the compressor in providing the high gas velocity.

Upper Pipes Do Most Work

In the common type of atmospheric condenser the gas from the compressor usually passes through three pipes at the bottom of the stand and then goes to the upper pipe, from which it descends successively through each pipe until the liquid drain is reached. As liquefaction develops, the condensate will flow downward with the uncondensed gas and each pipe will accumulate more and more liquid until the liquid connection to the receiver is reached, at which time the condenser pipe will be more or less flooded. Extensive investigations, using accurate measuring devices, with a bleeder-type atmospheric condenser have indicated that from 50 to 65 per cent of the total weight of the ammonia condensed takes place in the upper pair of pipes. This action of the condenser is contrary to what one would expect, inasmuch as the gas passes through 200 ft. of the condenser piping before reaching the upper pair of pipes. However, these pipes are exposed to the coldest condensing water, whereas the liquefaction occurring in the rest of the condenser must be in pipes with a successively increasing temperature of cooling water. With these tests as a guide, it is reasonable to expect that the same percentage of liquefaction will occur in the upper pair of pipes in the common type of atmospheric condenser, in which case the liquid will need to work its way through all the remaining pipes to the liquid connections to the receiver.

In the bleeder condenser the advantage not found in other types is the prompt removal of the condensate. The fact that the bleeder condenser has a gas flow

counter-current to that of the water flow is immaterial and it has no advantage over the parallel flow condenser, because in the saturated region the temperature of the ammonia during liquefaction is practically constant if air is not present, and the action of the two condensers is very nearly identical except as regards the direction of the gas flow and the disposal of the liquid condensed. Still following the known action of the bleeder condenser, one may safely state that in the double-pipe condenser the bulk of the condensation occurs in the bottom pipes where the coldest water is to be found. The remaining 40 or 50 per cent will be condensed in the other pipes, but the flooding of the pipes will be less than in the case of the common atmospheric condenser, and it is found that with the double-pipe condenser less surface is required per ton of refrigeration.

In the film theory of heat transfer, the velocity of flow of the gas and of the water are important. This theory considers that a film of the liquid or of the gas about 0.001 in. thick, capable of considerable resistance to heat flow, is always adhering to the heat transfer surfaces. The film is removed to a greater or lesser degree, depending on the intensity of the motion of the fluids surrounding these surfaces and the rate of heat transfer is changed accordingly. In the double-pipe condenser the water velocity is capable of being changed at will, and one is led to believe that in the flooded condenser the pipes are choked to such an extent that the gas velocity is increased appreciably. However, in the common and the bleeder type and in the vertical shell-and-tube designs the water velocity cannot be changed to any noticeable extent and thereby cannot enter into the discussion of the factors affecting heat transfer.

Action in Shell-and-Tube Design

In the shell-and-tube condenser the gas enters the shell. As liquefaction proceeds, the ammonia runs down the tubes and collects at the bottom of the shell. There is never any appreciable amount of liquid on the tubes and what is condensed is immediately removed from the surface by gravity, although in all likelihood the greater part of the liquefaction occurs at the top of the condenser where the water enters the tubes. The heat transfer surface, therefore, is more effective in this design, because all the tube surface, not submerged by the liquid at the bottom of the shell, is capable of performing its share of the work.

Nothing has been said of the action of non-condensible gas, as for example, air. For a certain set of operating conditions the presence of air increases the condenser pressure and the horsepower required for the compressor and reduces the value of the coefficient of heat transfer. According to Dalton's law the total pressure exerted, and registered by the gage on the condenser, is the sum of the pressures of the ammonia acting alone and that which the air would exert provided it occupied all the volume of the condenser by itself. This is expressed as $p_{total} = p_1 + p_2$, where p_1 is the pressure of the air and p_2 is the pressure of the ammonia.

If the air is purged out of the condenser the equation becomes $p_{total} = 0 + p_2$, or $p = p_2$.

If the action is such that diffusion, which varies inversely as the square root of the vapor density, is not possible, as is usually the case in pipe condensers during operation, and the air collects at one end of the condenser, it exerts an action similar to that of a piston on the entire condenser and liquefaction will take place at a temperature corresponding to the total pressure $p_1 + p_2$, even in the zone which has practically pure ammonia. However, should this liquid pass through or further liquefaction take place in the zone where the air is located, the liquid temperature will tend to be reduced to that corresponding to the pressure p_2 of the ammonia in that zone. Both because of the greater horsepower required and because of the probable increased liquefaction temperature, air and other foreign gases are most undesirable in the ammonia condenser.

In conclusion it can be stated that any condenser which by its design has an action tending to "flood" the surface because of the delay in draining the condensate is also a mistake. For condensers working under similar conditions, that condenser which can free itself of the condensate most quickly is the best.

Misconceptions Regarding Boiler Explosions

By Edward Ingham*

IN THE early days of steam boilers, it was commonly believed that nearly every boiler explosion was caused by shortness of water. Thus it was supposed that the fireman had shut off the feed and allowed the level of the water to fall so low that the furnace crowns had become bared and hence red-hot, and, having discovered the condition of the boiler, had turned on the feed again. Then the cold water, falling on the hot crown plates, was instantly converted into steam, the volume of steam produced being so great that the safety valves were incapable of relieving the pressure set up, an explosion being the inevitable consequence. This belief was entertained by many of the leading authorities of the day.

Experiments Dispel Old Belief

As far back as 1867 the Manchester Steam Users' Association conducted experiments to find out what took place when cold water was injected into red-hot circulating boilers. It was found that in no instance an explosion took place. An account of the experiments was given in the association's report for February, 1867.

The results of the experiments tended to dispel the belief that "an instantaneous and ungovernable amount of steam is generated by throwing a little water on the red-hot furnace crowns of a boiler," and it was naturally suggested that if no risk of explosion was incurred by pouring cold water into a boiler with overheated crown plates, it would be advisable to turn on the feed in the event of a boiler having become short of water.

What, however, would be the effect on the furnace crowns in an internally fired boiler? Past experience had shown that if cold water were poured into a boiler shortly after the hot water had been blown out, straining of the riveted seams of the shell resulted, the straining being so severe in some instances as to set up fractures or "seam rips" along the lines of rivet holes. Evidently the pouring of cold water onto the hot furnace crown plates, although not the direct cause of an explosion, might strain the furnaces to a serious or even dangerous extent. Only an actual trial could supply

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reliable information as to what would actually take place.

The association therefore arranged to carry out a series of experiments on a full-sized Lancashire boiler. A report of these experiments was published in 1889.

The experiments, besides furnishing a great deal of valuable information that does not concern this article, "showed that showering cold water onto the furnace crowns when red hot did not lead to their rending by sudden contraction either transversely or longitudinally, nor did it lead to a violent generation of steam which the safety valves could not control and the shell could not resist. On the injection of the feed, when one of the safety valves was seated and the other open, the pressure rose in one and a quarter minutes from 6 lb. to 12 lb., and when both safety valves were seated, it rose in three-quarters of a minute from 6 to 27 lb., and then gradually fell. On the injection of the feed, when the safety valves were blowing, no increase of pressure could be observed. On the contrary, it began to fall, and the hand of the pressure gage began to glide back. There was no collapse; there was no rent, either in the furnace tubes or in the shell, and no movement of the boiler whatever."

What the Experiments Showed

In certain of the experiments it was found that the furnace crowns had suffered some amount of straining and distortion, but in others they appeared to have sustained no damage whatever.

To draw the fires, however, may be attended with considerable risk, because it stirs them up and increases the heat of the furnaces, so that if the crown plates are on the point of collapsing, the danger is increased. It is generally recommended nowadays that in cases of shortness of water, if the furnace crowns are not already overheated, the best plan is to shut the dampers, turn on the feed, lift the safety valves and smother the fires with damp ashes.

If a boiler be exposed to a greater pressure than that for which it was designed, or if it be allowed to become unduly corroded or to develop serious fractures, or if certain parts be allowed to become overheated, it cannot be a matter for wonder if an explosion occurs.

Thanks largely to the valuable work of the boiler insurance companies, boiler explosions within recent years have been greatly decreased.

If a boiler is properly designed and well constructed of high-class reliable material, and if it be worked under satisfactory conditions and be regularly inspected by experts thoroughly acquainted with the various defects from which boilers suffer, the possibility of explosion is almost eliminated.

It is true that boiler explosions still take place from time to time, but almost invariably these disasters are the result either of defective construction or of carelessness and neglect on the part of the steam user. Far more often than not the steam user is the responsible party. Modern boilers are generally made throughout of the highest class of material, and constructional defects are comparatively rare. A study of the reports on boiler explosions issued from time to time by the British Board of Trade is sufficient to convince anyone that explosions from malconstruction are few in comparison with those that occur from defects which have gradually developed, but which, in the majority of cases, might have been prevented by a due amount of care on the part of the boiler owner.

Before concluding, some reference should be made to a popular fallacy in regard to what happens with the boilers on a ship sinking in deep water. The popular belief is that the boilers explode. As a matter of fact, they never do. A moment's consideration will show that rather than explode the boilers will collapse. When the vessel sinks, the boilers are exposed to the cooling action of the sea water, and the tendency is to condense the steam and form a partial vacuum. If the boilers are efficiently covered with good non-conducting covering, an appreciable time may elapse before condensation occurs. In the meantime the vessel will probably have sunk to a depth where the pressure of water is sufficient to crush the boilers beyond recognition. Collapse, and not explosion, is therefore what takes place. The popular belief that the boilers explode is no doubt due in large measure to the fact that when the ship sinks, great volumes of steam are seen by onlookers and noises resembling muffled explosions are heard. The clouds of steam are explained by saying that immediately the water reaches the boiler furnaces large volumes of water are at once converted into steam, which escapes up the funnels. The noises may be caused by the rapid crushing in of the funnels, due to the external water pressure, or possibly to the collapse of the bulkheads.

New Life for Old Turbines

The *Brown Boveri Review* for March, 1926, remarks that in many power stations out-of-date turbine generator sets are held in reserve and have not been used for years. Frequently it is possible to reconstruct such machines so that they may be placed in every-day service once more, by resorting to one of the following methods:

1. For high-speed sets, it is often possible to replace the old blades, which are undoubtedly eroded and corroded, with blades of modern profile. The steam consumption may be better than that originally guaranteed for the new machine.

2. For low-speed sets, one may substitute a modern high-speed geared turbine that will develop a favorable steam rate, without changing the generator or the condenser. Gains of 10 or even 20 per cent in the steam rate become possible without alterations in the boiler plant. A further improvement is naturally obtained if it is possible to increase the steam pressure or the superheat.

3. Rebuilding the old turbine to adapt it to the use of exhaust steam for heating purposes often presents advantages. In many cases old turbines may readily be rebucketed and arranged for high back-pressure operation for heating buildings or for process heating.

4. Using the generator of the set as a synchronous condenser may serve to increase the system power factor. This of course applies only to alternating-current machines. Usually the generator is uncoupled from the turbine and is brought to synchronous speed by means of some stand-by motor equipment. In some cases it is possible to use the turbine to bring the generator to synchronous speed, and then allow the turbine to run light in vacuum, driven by the alternator. This has the advantage of maintaining the steam equipment always ready for service, but has disadvantages in that vacuum must be maintained continuously and that the turbine is run under unfavorable conditions.

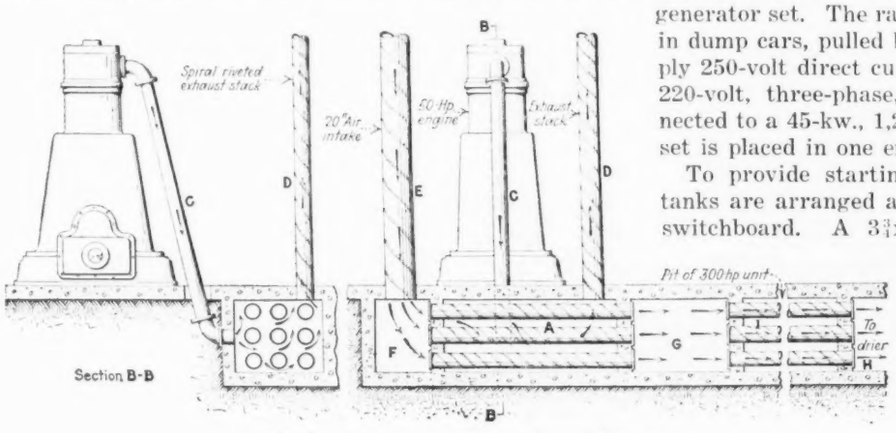
Oil Engines Drive Georgia Brick Plant

Georgia White Brick Co., Gordon, Ga., Uses Three Oil Engines of 500-Hp. Capacity—Exhaust Heat Used in Brick Drier—Jacket Water Fed to Pug Mill

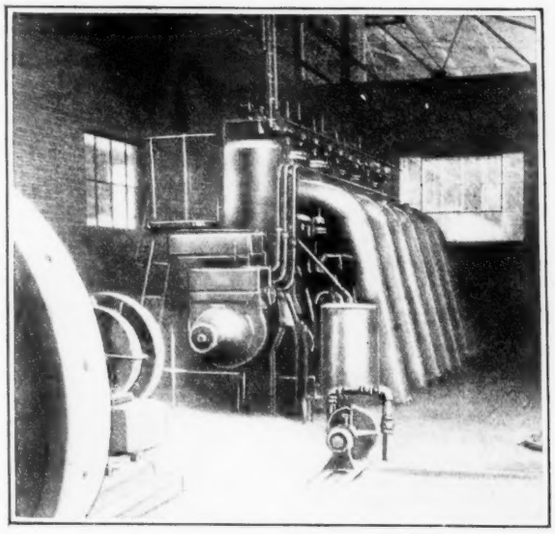
MUCH has been written concerning the possibility of waste heat recovery in oil-engine plants, but the Georgia White Brick Co. has carried out the plan to the practicable limit. The utilization of the waste heat in the exhaust is usually understood to cover the generation of low-pressure steam, but the amount of such a recovery is not great, inasmuch as the gases must not be cooled lower than about 50 deg. F. above the saturation temperature of the steam. Lower temperatures entail too large a heat transfer surface and set up "sweating" on the gas side of the surface. This sweating produces serious corrosion when the fuel used contains any considerable amount of sulphur. The brick company employs the exhaust gases to heat air for the brick driers, and as this air leaves the regenerator around 150 deg. F., the recovery is a large part of the waste heat.

The brick plant, which makes white and buff brick from a mixture of sand, aplite rock and kaolin, is housed in a steel building with brick sidewalls, 833 ft. long by 100 ft. wide. The engine room is placed alongside the pug mill toward one end of the building, but is separated from the rest of the plant by a brick screen wall. When first erected, a 150-hp. two-stroke-cycle oil engine and a used 50-hp. engine of the same type but using high compression were purchased in order to run the plant to capacity. The 50-hp. unit is direct connected to a 32-kw., 220-volt, 257-r.p.m., three-phase, 60-cycle alternator; the 150-hp. unit is direct connected to a 100-kw. alternator, and a 300-hp. engine drives a 200-kw. direct-connected alternator. All of the exciters are driven from the extended engine shafts by silent chains.

Water for the brick plant is obtained by an air lift from a deep well, a 6x8-in. horizontal compressor driven



Air heater on engine exhaust lines



High-compression 300-hp. oil engine

by a 10-hp. motor furnishing the air supply. The water is discharged into a brick reservoir, and the jacket water for the engines is drawn from this storage by a centrifugal pump, belt driven from the engine. Although each engine has a separate pump, the suction and discharge water lines connect to common headers. In this way the pump of one engine can supply water to the other units. After leaving the jacket, the water is discharged into a steel tank placed on the engine-room screen wall. This water is then used to lubricate the brick dies and to pug the clay. A 6-in. overflow returns any excess water to the outside reservoir. The economy in this arrangement is considerable, for water is necessary at the brick machines and in a year the reduction in pumping cost is large.

The 150-hp. unit has no provision for reclaiming the lubricating oil, it being an earlier type, but the 50-hp. and the 300-hp. engines are equipped with continuous filters and pumps that draw the oil from the crank cases and put it through the filters. This results in a saving of about 50 per cent in the lubricating oil per engine rated horsepower-hour.

Fuel oil which ranges from 32 to 40 deg. Beaumé is purchased in carload lots and is stored in an above-ground steel tank.

The switchboard consists of seven panels; three of these are for the generators, three are feeder panels and one carries the switches, etc., for the motor-generator set. The raw material for the plant is handled in dump cars, pulled by an electric locomotive. To supply 250-volt direct current to the trolley line, a 100-hp., 220-volt, three-phase, slip-ring motor is directly connected to a 45-kw., 1,200-r.p.m., 250-volt generator. This set is placed in one end of the engine room.

To provide starting air for the engines, seven air tanks are arranged along the building wall back of the switchboard. A 3¾x4-in. vertical single-acting compressor belted to a 3-hp. squirrel-cage motor is used to charge the tanks; a similar compressor direct connected to a 3-hp. gasoline engine is provided for a stand-by.

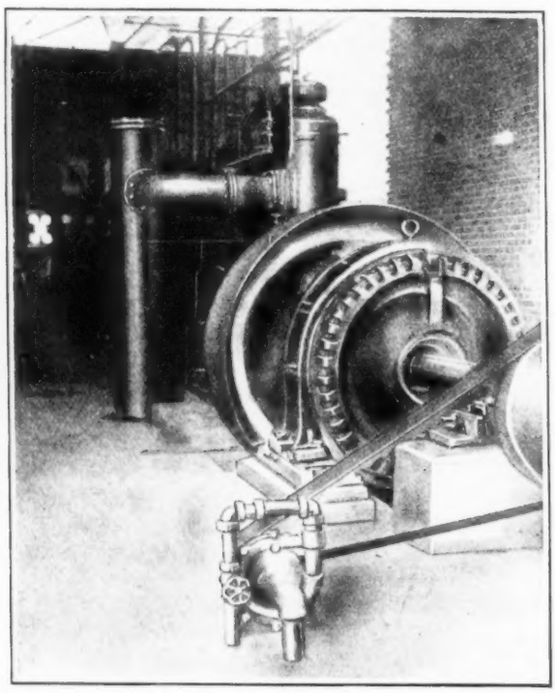
As has been stated, much of the heat of the exhaust is recovered. A diagrammatical layout of the

PRINCIPAL EQUIPMENT

Georgia White Brick Company's Plant

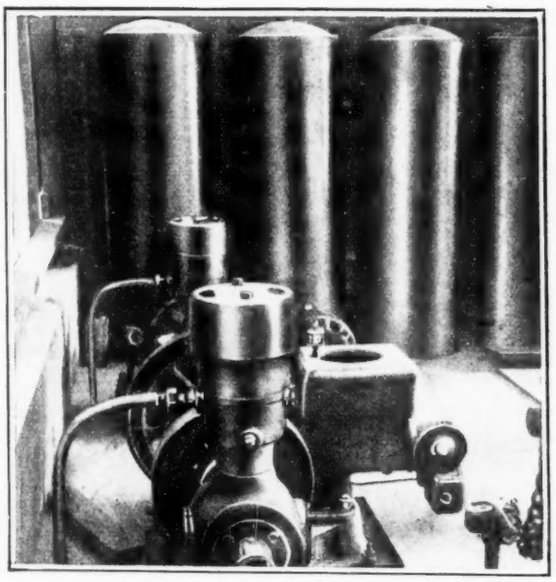
Engine, hp.	50
Drive	Direct connected to 32-kw., 220-volt, three phase, 60-cycle, 257 r.p.m. alternator
Exciter	3.5 kw., 1,400 r.p.m., chain driven
Engine, hp	150
Drive	Direct connected to 257 r.p.m., 220-volt, three phase, 60-cycle, 100-kw. alternator
Exciter	7.5 kw., 1,400 r.p.m, chain driven
Circulating pump	1½ in., belt driven centrifugal
Engine, hp	300
Drive	Direct connected to 200-kw., 257-r.p.m., 220-volt, three-phase, 60-cycle alternator
Exciter	10 kw., 1,400 r.p.m., chain driven
Circulating pumps	2-in., belted centrifugal
Make of engines, generators, exciters and other equipment	Fairbanks, Morse & Co.
Motor-generator set	100 hp., 220-volt, three-phase, 60-cycle motor, direct connected to 45-kw., 1,200-r.p.m., 250-volt generator
Make	Fairbanks, Morse & Co.
Switchboard	Seven panels
Make	Westinghouse Elec. & Mfg. Co.
Air compressor	3½ x 4-in., belted to 3-hp. motor
Air compressor, standby	3½ x 4-in., direct connected to 3-hp. gas engine
Make	Fairbanks, Morse & Co.
Air-lift compressor, size	6x8 in.
make	Sullivan Machinery Co.
drive	Belted to 15-hp. F. M. & Co. 1,200-r.p.m., motor.

regenerator is shown herewith. Alongside the three engines is a concrete tunnel approximately 5x6 ft. in section. Lengths of spiral-riveted pipe are placed in this tunnel and concrete partitions are set at the ends so that the exhaust gases coming down the line *C* can circulate around these pipes before passing out the exhaust stack *D*. Air is drawn down *E* into the air chamber *F* by a motor-driven draft fan at the drier; it then flows through the pipes *A* into the chamber *G* and then through pipes *I* of the second engine pit into the air tunnel *H*, which carries it to the fan at the brick drier.



Plant uses a motor-driven compressor with a gasoline-driven stand-by

The exhaust gases leave the engine about 400 deg. F. when the engine is carrying full load and are discharged out of the stack at approximately 150 deg. Assuming an outside temperature of 60 deg. F., this means that of the heat thrown out of the engine in the exhaust gases (400 — 150) ÷ (400 — 60) = 73 per cent is recovered by the regenerator. In this type of engine operating at around three-quarters load it is probable that for each kilowatt-hour generated at last 5,000 B.t.u. usually is lost in the exhaust. The recovery is then approximately 3,600 B.t.u. per kilowatt-hour and the engines may be credited with 27 per cent of their fuel cost. When a plant is developing between 75,000 and



The 150-hp. engine is of an early design

85,000 kw.-hr. a month, the worth of the annual waste-heat recovery is apparent.

As at present operated, the 300-hp. and the 150-hp. engines are operated during the day shift, and at night only the 150-hp. unit is run. An engineer is employed during each of the two shifts, with a chief engineer in charge of the engine room as well as of all of the machine maintenance in the mill.

A CONSEQUENCE of the use of closed circuit generator air-cooling systems which is hard to evaluate but which is nevertheless a very acceptable result is the reduction of noise in the turbine-room basement. The roar incident to the suction and discharge of large quantities of air by a large generator is very pronounced and far from pleasant. A properly designed closed circuit cooling system practically eliminates this noise and makes the plant a pleasanter place in which to work, at the same time making it much easier for operators to talk with one another in the basement. Although this is easily recognized as a real asset in plant operation, it is naturally difficult to put a money value on it in considering the question of air-cooling systems.

TURBO-COMPRESSORS—In European practice, turbo-compressors and blowers have almost completely superseded the larger and more expensive reciprocating machines in mines, in iron works and in the chemical industry. Turbo-compressors are also meeting with increased favor in pneumatic grain-conveying plants. The great advantages possessed by such blowers and compressors are primarily due to the fact that they are purely rotary machines, and also to the good quantity and pressure regulation that can be obtained.

Locating Faults in Electric Elevators—Alternating-Current Controllers

A General Description Is Given of Different Types of Alternating-Current Elevator-Motor Controllers, and How to Locate Troubles in Such Equipment Is Explained

BY CHARLES A. ARMSTRONG

THERE are two methods of applying alternating current to elevator service: (1) convert it into direct current and use direct-current elevator equipment, and (2) apply it direct by the use of suitable alternating-current motors and control equipment. The former is usually done only for high-speed elevators, and in such cases the troubles that may develop in the elevator equipment are the same as those for any direct-current equipment. The development of satisfactory magnetic contactors and a brake magnetic for alternating-current motor control has offered many difficult problems. To get away from these difficulties alternating-current motors have been applied to elevator service with direct-current control equipment, the current for operating the controller being supplied by a small motor-generator set driven from the alternating-current power supply. In such installations the controller troubles will be practically the same as with direct-current equipment, but the motor troubles will be those of the particular type of alternating-current machine used, as will be subsequently discussed.

In direct-current work the requirements of elevator service have been met by the simple shunt or compound motors. With alternating current a wide variety of motors have been utilized, and even with these the high-speed direct-traction alternating-current machine is still something for the future to produce. The tendency toward the use of variable-voltage control for high-speed elevator work leaves little need for the development of a direct-traction elevator alternating-current equipment. With variable-voltage direct-current control a motor generator is required with each elevator-control equipment, so that the equipment is the same whether alternating or direct current is used.

In slow-speed alternating-current elevator service the motor may be connected directly across the line. This allows the use of the simplest kind of control equipment. In some of the earlier types of elevator equipment the controller was only a knife-type reversing switch mounted directly on the shipper wheel. This switch

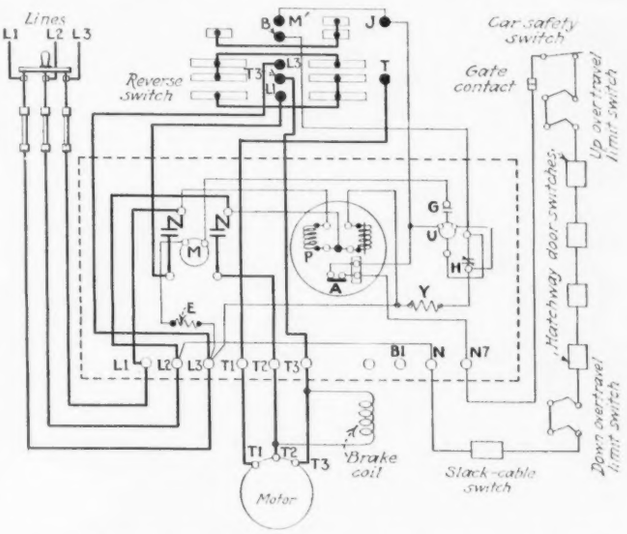
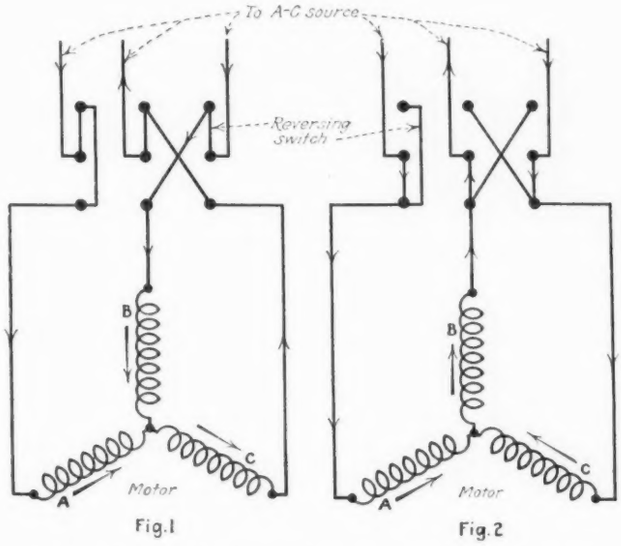


Fig. 3—Wiring diagram of controller, Fig. 4, for use with hand-rope controlled elevator

was close to one position or the other according to the movement of the control equipment by the operator in the car. Figs. 1 and 2 show elementary diagrams of the motor circuits for such a control equipment for a three-phase squirrel-cage motor. The arrowheads indicate the instantaneous direction of the current, and it will be seen that the direction of the current in the motor windings *B* and *C* is reversed in Fig. 2 from that in Fig. 1. Such equipment is simple but, as some of the earlier types were designed, was a source of considerable trouble, due to burned and loose contacts, particularly if the elevator service was heavy.

Such control equipment gives the motor and elevator machinery practically no protection other than overload, and this only if the motor happens to be properly fused. The latter was rarely the case with the old-type squirrel-cage motors, since the starting current was so high. When the fuses were made large enough to take care of the starting current, they were too large to give proper protection to the motor during normal operation.



Figs. 1 and 2—Diagrams of connections of a three-phase motor to a reversing switch

If one phase is open on a two- or three-phase motor, the motor cannot start. If the machine is connected to the line and left with one phase open, the heavy current flowing in the other part of the winding will overheat and destroy the motor's insulation. Motor windings have been burned out due to one phase opening, by a blown fuse or otherwise, and the operator pulling the control equipment to the on position and leaving it there, after it was found that the elevator would not start.

A direct-current motor cannot be reversed by interchanging the line wires, but if the wires of any one phase are interchanged on a line supplying polyphase alternating-current motors, it will cause a reversal of the motor's direction of rotation. There are a number of cases on record where elevator motors have been reversed in this way and some of them with disastrous results to the elevator equipment. Therefore an elevator alternating-current motor, in addition to being protected against overload, should also be provided with open-phase and reverse-phase protection. The diagram, Fig. 3, shows the wiring for such a controller, as built

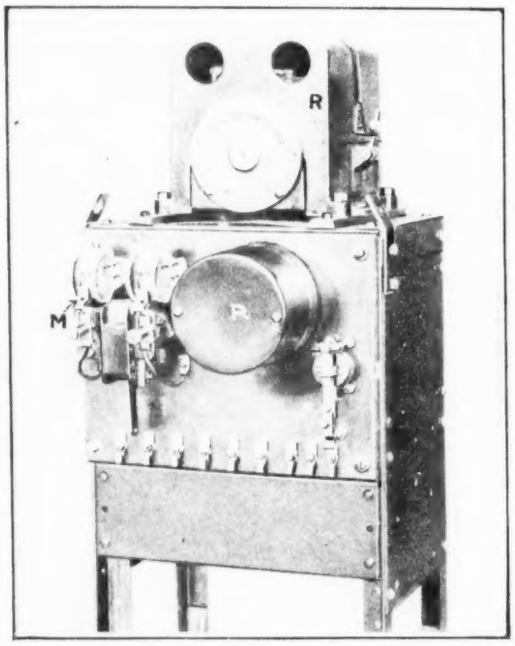


Fig. 4—Semi-magnetic type alternating-current controller

by the Cutler-Hammer Manufacturing Co., for use on an elevator controlled by a hand rope in the car. The control for a traction machine would be the same except that the slack cable switch would be left out.

The complete control equipment corresponding to the diagram, Fig. 3, is shown in Fig. 4. Reversing of the motor is done by a cylindrical-type switch, Fig. 5, and shown at R, in Fig. 4. The phase-failure and reverse-phase relay is shown at P, an undervoltage relay at U and a magnetic line contactor at M. These parts are indicated on the diagram. In this diagram the car safety switch, overtravel limit switches, hatchway-door switches, gate-contact and slack-cable switches are common to both direct-current and alternating-current controllers.

Tracing out the circuit for the line contactor M, it is found to go from line terminal L_1 through all the protective devices connected between N and N_1, then through contact A on the reverse-phase relay P, through the coil on the undervoltage relay U and to line terminal L_2, if the reverse switch is in the off position. The energizing of this circuit holds the undervoltage con-

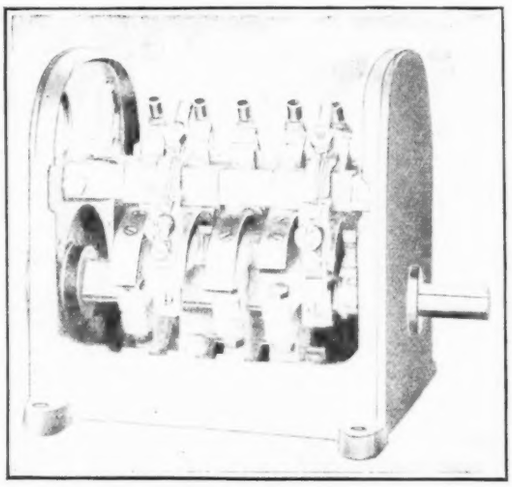


Fig. 5—Cylindrical-type reversing switch

tactor closed as long as the circuit remains energized and completes the circuit for the line contactor coil M. This circuit is from L_2 through all the protective devices included in the undervoltage relay-coil circuit and to M' on the reverse switch. When the reverse switch is closed to either position, the circuit is completed from M' to B through contact G on the undervoltage relay U and coil M to L_3, thus energizing this coil and causing it to close its contacts, and completing the circuit for the motor. The motor contacts on the reverse switch are so arranged that they close before switch M and open after switch M, so that all the making and breaking of the main circuit is done on this switch, which is designed for this class of service. Since there is no

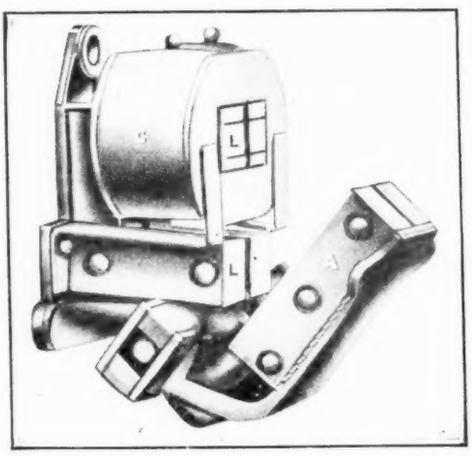


Fig. 6—Alternating-current contactor magnet

current broken on the reversing-switch contacts, these contacts will cause little trouble if properly adjusted and the cylindrical surface lubricated with a little clean vaseline.

The undervoltage relay is to prevent the car starting unexpectedly after a voltage failure, if the control happens to be left in the run position. On a full magnet-type control the car switch is made self-centering so that it cannot be left in the on position, but the hand-rope control will remain in almost any position in which it may be placed. The undervoltage release also prevents the car from starting should the operator be holding the controller in the on position and someone close the landing doors or car gate, if door and gate switches are used, without first moving the controller to the off position. If contacts *M'B* are closed on the reverse switch, as they are with the switch in either full-on position, a circuit is provided from contact *A* on the reverse-phase relay *P* through *M'B* on the reverse switch, to *H* on the undervoltage relay, through resistance *Y* to L_2. This shunts out the coil on the undervoltage relay *U* and it cannot close its contact. When the reverse switch is in the neutral position, contacts *M'B* are open and the coil of the undervoltage relay *U* is in circuit, as previously explained. Closing of the undervoltage relay opens contacts *H* and prevents the relay's coil being short-circuited when the reverse switch closes, but this does not interfere with the circuit for coil *M*, which has been previously described.

If any of the safety devices in the undervoltage relay's circuit are open or making poor contact, the relay cannot close and the control will be inoperative. A check can be made to determine if the trouble is in the safety devices or in the controller, by temporarily connecting *N* and N_2 terminals together. If the trouble is in the car or hatchway safeties, the undervoltage release should close. In making this test care must be exercised since, with terminals *N* and N_2 short-circuited, no protection is provided against the car or counterweights being pulled into the overhead work. Therefore the car should not in any case be started with the *N* and N_2 terminals short-circuited.

If it is found that the undervoltage relay will close with the car and hatchway safety devices cut out of circuit, it is known that the trouble is somewhere in this part of the circuit. On the other hand, if the undervoltage relay does not close, it will be known that the trouble is somewhere at the controller. One of the first things to test is the fuses and make sure that power is getting to the controller. When this has been made sure of, then the reverse-phase relay should be examined to see if its contacts are closed. If it is in normal position, the circuit through its contacts can be checked by disconnecting the leads from contacts *A*, at N_2 and at relay *U*, and testing through with a test lamp. If contacts *A* are causing the trouble, the elevator may be operated temporarily by disconnecting the leads from contact *A* and connecting them together. When this is done, care should be taken, when first starting the car, to make sure that it runs in the direction corresponding to the position of the controller.

In case of a reversed phase, the fault can be corrected by crossing the wires of any one phase at the line switch. However, this should not be done until it is ascertained how the phase was reversed on the line and what is going to be done to correct the trouble. If the trouble was corrected at the motor's switch and the elevator put into service, then afterward to make conditions normal on the line a phase is reversed, the elevator will again be operating in the wrong direction on the controller. To avoid such an occurrence it should be definitely determined what is going to be done on the line.

Where trouble is being experienced with improper operation of the reverse-phase relay, the manufacturer's instructions should be consulted carefully. In case it

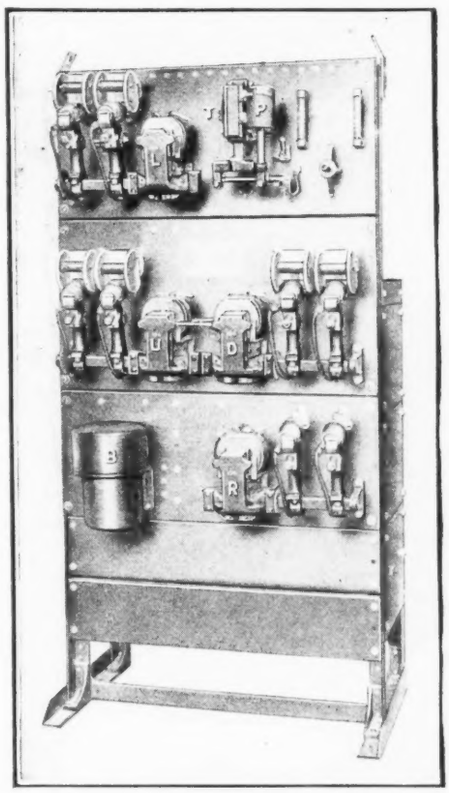
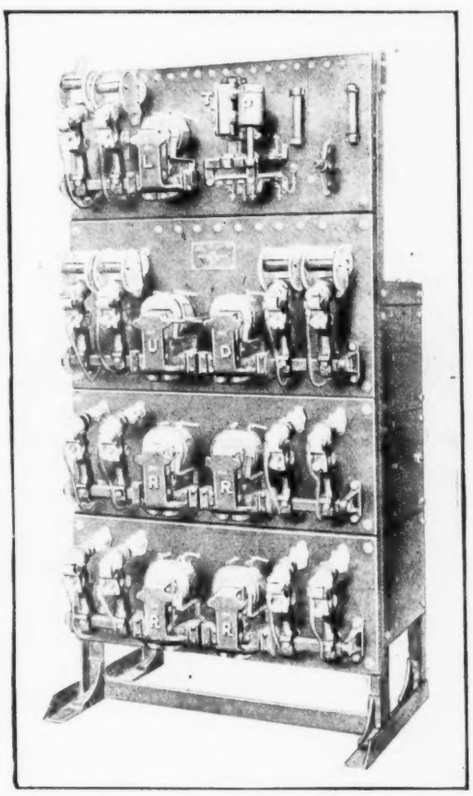


Fig. 7 (Left)—Full-magnetic type controller for squirrel-cage motor starting with primary resistance

Contactor *L* is the line switch; *U* and *D*, up- and down-direction switches; *R*, contactor for short-circuiting the primary resistance; *B*, reverse-phase relay; and *T*, timing relay.

Fig. 8 (Right) — Full-magnetic type controller for wound-rotor type motor

Switches *L*, *U*, *D* and *T* are the same as for Fig. 7. Contactors *R* close and cut out the rotor resistance in four steps.



is a type with a mercury switch and this switch fails, it will probably be best to send the relay back to the factory to have a new one installed. The adjustment of this switch is a sensitive operation and should not be attempted by anyone except a competent worker.

After the undervoltage relay closes, if the line contactor *M* will not close, two sources where the trouble may be are the contact on the undervoltage relay and contacts *M'B* on the reverse switch. A resistance in series with a coil is always a potential source of an open-circuit. In Fig. 3, *Y* is in series with the undervoltage relay coil *U* and resistance *E* is in series with coil *M*. In case of these contactors being inoperative, the resistances corresponding to the contactor in trouble should be tested through with a lamp. In many cases resistance coils are of comparatively high resistance and if tested through with a lamp, the latter may not glow if of the carbon type, so that care must be exercised in making such tests, if wrong conclusions are to be avoided.

Alternating-Current Contactors

Alternating-current magnets require careful adjustment if they are to operate quietly. They are usually designed with a closed magnetic circuit, as in Fig. 6. The coil *C* is mounted on a laminated iron loop, and a laminated armature *A* seats on the two pole faces *L* and *L* when the contactor closes. The pole faces and armature are ground to a good fit. Any dust, lint or oil collecting on these surfaces to prevent the armature from properly seating may cause the contactor to be noisy. In the pole face of these contactors there is a copper loop, known as a shading coil. If this loop becomes broken, it will also cause noisy operation. On some types rotating types of magnets are used. These operate similar to small polyphase motors, and are sometimes called non-sealing magnets.

Current taken by a coil on an alternating-current circuit is limited by the ohmic resistance of the coil's circuit and by the counter-electromotive induced in the coil, just as in the primary winding of a transformer. When the coil circuit, Fig. 6, is first closed, the contactor is open; consequently there is a long air gap in the magnetic circuit. This long air gap does two things: it greatly reduces the number of magnetic lines set up in the core per ampere in the coil, and reduces the counter-electromotive force in the coil so that the current flowing will be considerably larger than when the magnetic circuit is complete iron, as when the contactor is closed. On this account if the current is left on a contactor coil, when the contactor does not close it is likely to burn out in a short time. If trouble is being experienced with a contactor coil burning out, the possibility of the contactor not closing should be looked into carefully. On direct current, a coil might have a small part of its winding short-circuited without causing serious trouble. On alternating current the short-circuited section of a coil becomes a short-circuited secondary of a transformer and might prevent the coil from closing the contactor, or if the contactor did close, the current flowing would be sufficient to cause the coil to burn out in a short time.

It is quite general practice, where single-speed high-resistance rotor induction motors are used on slow-speed elevators, to start the motor with a resistance connected into the primary circuit, which is cut out of circuit after a given period. This is generally cut out in one step by a contactor. The closing of this contactor *R* is generally controlled by a timing relay *T*, as in Fig. 7. It is essential that this timing relay be kept in operating condition, for if the stator resistance is not cut out when lifting heavy load, the motor may not be able to start the load and when lowering a heavy load the elevator may race. When lowering a heavy load, the induction motor becomes a generator, pumps back into the line just as a direct-current motor does, and acts as a brake to keep the elevator under control. If the primary resistance is in circuit, the motors speed will have to increase considerably above normal to supply the necessary braking current.

An open-circuit in one leg of this primary resistance would prevent the motor from starting and where a phase-failure relay is used may cause this relay to function and open the line contactor. If this does not occur, when the resistance contactor closes the motor will start but will probably cause an unpleasant movement of the car. These controllers may be operated either from a hand rope in the car—that is, semi-magnetic—or full magnetic, Fig. 7, operated from a car switch. Where a full-magnetic type controller is used, the direction switches are magnetic contactors controlled from the car switch as on direct-current motor controllers. What has been said in previous articles regarding the troubles in the direction-switch operating circuits for direct current applies to alternating-current controllers.

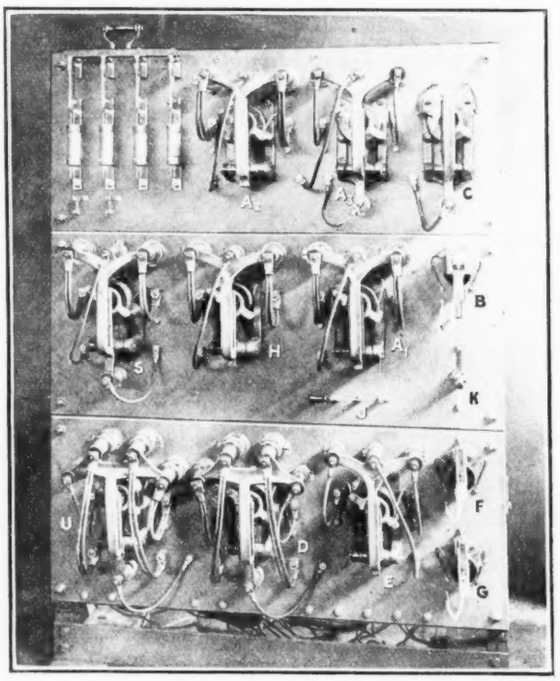


Fig. 9—Full-magnetic type controller for two-speed double-winding squirrel-cage motor

Contactors *U* and *D* are the up- and down-direction switches; *E*, buffer-resistance contactor; *F*, up direction-switch interlock; *G*, down direction-switch interlock; A_1, A_2 and A_3, accelerating contactors; *H* and *S*, high-speed and slow-speed contactors; *B*, high-speed interlock; *C*, speed-change interlock; *J*, control throw-over switch; and *K*, control switch.

Another method of applying alternating-current motors to slow-speed elevators is to use a wound-rotor motor with external resistance. Fig. 8 shows a full-magnetic type of controller for such a machine. The top, contactor *L* is the line switch; contactors *U* and *D* are the direction switches, the four contactors *R* are

to cut out the rotor resistance in four steps and T is the timing relay that controls the closing of the accelerating contactors R. As soon as the controller is energized, the timing relay T closes, but is immediately released and starts to open, the time of opening being controlled by a dashpot P. It is necessary for this relay to open and close its contacts for the accelerating contactors R to close. In case of the accelerating contactors failing to function, one of the first places to look for trouble is the accelerating-relay contacts. On the other hand, if the motor is being accelerated too quickly, the relay contactor may not be closing or the dashpot may allow the relay to open too quickly.

With the wound-rotor motor the same trouble can occur in the stator circuit as in the squirrel-cage motor. In addition to this the rotor circuit is to be reckoned with. In case of the motor failing to come up to speed the rotor resistance may not be cut out of circuit or the brushes may not be making good contact on the collector rings. Under certain conditions with one phase open in the rotor, the motor will only attain about half speed and remain at that. Single-phase operation of the rotor will also cause noisy operation.

Multi-Speed Type Motors

For car speeds above 150 to 200 ft. per minute two-speed motors are generally used. These motors may have a single winding in the stator which is regrouped for one-half and full speed such as 450 and 900 r.p.m. Instead of using a single winding, two windings may be used in the same stator. With this arrangement most any ratio of speed can be obtained up to 1 to 6. For example, one winding would give a theoretical speed of 200 and the other 1,200 r.p.m. Instead of using a single motor, two are frequently used in tandem. Two stators are placed in a single frame and two rotors are keyed to the same shaft. One of the stators is wound for slow speed and the other for high. In general only a squirrel-cage type of rotor is used, but in some installations the high-speed machine has a wound rotor, connected to external resistance. There are two methods of starting these motors: (1) to start on the low-speed winding and then switch to the high-speed; (2) all the starting is done on the high-speed winding. In either case the slow-speed machine is switched in during the stopping period to slow the machine down before disconnecting from the line and applying the brake to stop the machine. Except that control is provided for two motors instead of one and sometimes a governor-operated switch is provided to hold the slow-speed motor's contact in after the high-speed motor has been cut out, until the elevator has slowed down, the control for these equipments does not offer any difficulties not found with other types of full-magnet type controller. With these equipments, if trouble is being experienced with the brake running hot or not stopping the car quickly enough, it should be made sure that the slow-speed motor is being cut into service during the stopping period. If this is not done, all the work of stopping the elevator from high speed will have to be done on the mechanical brake and may result in unsatisfactory operation.

Blowing Down the Water Column is vital to the safety of the boiler and to the durability of the water column connections. The quiescent condition of the water in the column invites clogging of the connections by mud-forming impurities in the water.

Pulley Speeds and Diameters

By R. B. Smith

THE subject of relative pulley speeds and pulley diameters is constantly being revived, for once every so often the engineer is called upon to determine the size of pulley required for a specified drive and formulas are not always convenient. Work of this nature occurs so seldom that it is not reasonable to expect an engineer to keep fresh in his mind the methods to be used, but if he will once get clearly in mind what actually takes place when two pulleys are belted together, it will not be necessary to rely on formulas.

When a pulley makes a single revolution, a point on the rim will travel a distance equal to the circumference of the pulley—that is, a distance 3.1416 times the diameter. The distance traveled by this point in one minute will then be the circumference of the pulley multiplied by the revolutions made per minute. For this purpose the circumference of the pulley should be reduced to feet, as diameters are generally considered in inches.

When considering the problem from a theoretical standpoint, the slippage between the belt and the pulley may be neglected and it is therefore assumed that a belt passing over this pulley will have the same speed in feet per minute as was found for the point taken on the pulley rim; in other words, a point on the belt will travel the same number of feet per minute as is traveled by a point on the rim.

When considering the driven pulley, the same condition will hold good. A point on the rim of the driven pulley must travel in one minute a distance measured in feet equal to the travel of a point on the belt and consequently equal to the distance traveled by a point on the rim of the driving pulley. It follows, therefore, that in order to determine the revolutions made per minute by the driven pulley it is necessary only to divide the distance traveled in one minute by a point on the driving pulley by the circumference of the driven pulley, or if the circumference of the driven pulley is required, it is necessary only to divide the distance traveled per minute by a point on the driving pulley by the revolutions per minute of the driven pulley.

Stated in the form of a rule, one might therefore say that the circumference of the driving pulley multiplied by its revolutions per minute must equal the circumference of the driven pulley multiplied by its revolutions per minute. In view of the fact that for both the driving and driven pulley the circumference is found by multiplying the diameter by 3.1416, it follows that the circumference of the pulley will be in direct proportion to the diameter, and the factor 3.1416 may, therefore, be omitted, so that our rule will now read, the diameter of the driving pulley multiplied by its revolutions per minute equals the diameter of the driven pulley multiplied by its revolutions per minute. This may be expressed more briefly by the formula:

$$D \times RPM = d \times rpm$$

Where D represents the diameter of the driving pulley.
R the diameter of the driven pulley.
RPM the revolutions per minute of the driving pulley.
rpm the revolutions per minute of the driven pulley.

Once this ratio is thoroughly understood, the engineer can apply it without reverting to handbooks.

Turbine Exhaust Pressure Measurement

By W. A. Carter
Technical Engineer of Power Plants, Detroit Edison Co., Detroit, Mich.

IT IS very difficult to measure the pressure in the exhaust of a steam turbine, for the reason that the steam is flowing at high velocity and in a very irregular way. Since the pressure desired is the so-called static pressure, free from any impact or velocity

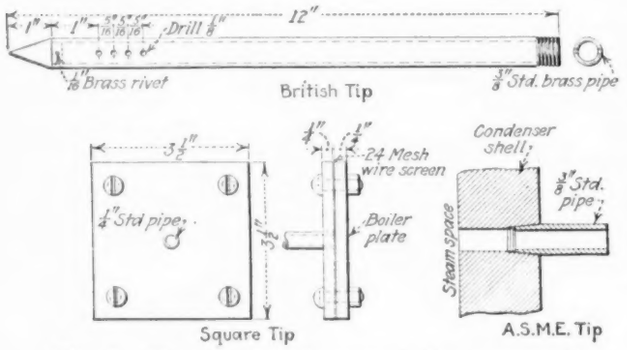


Fig. 1—Three types of pressure tips compared

effects, it is necessary to connect a gage or mercury column to some sort of "static" pressure tip.

Several forms of tip for this purpose have been suggested by various workers in this field. Fig. 1 shows two designs that seemed promising. The British tip consists of a length of $\frac{3}{8}$-in. standard brass pipe, with $\frac{1}{8}$-in. holes drilled near its end, which is closed by a pointed plug. This tip is so placed in the exhaust passage that the holes are directed at right angles to the flow of steam as nearly as the direction of steam flow can be estimated. The square tip consists of two pieces of boiler plate with a layer of fine-mesh wire

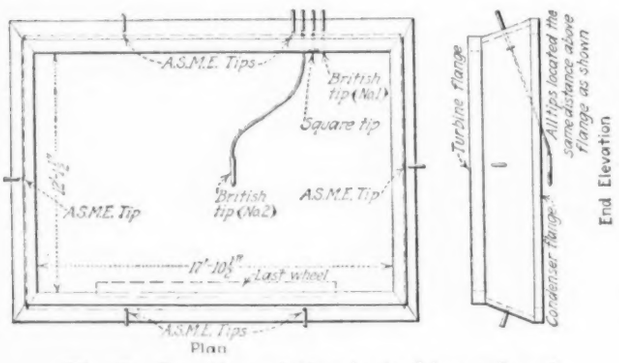


Fig. 2—Location of tips in turbine exhaust

screen clamped between them, the connection to the gage being screwed into the center of one of these plates. This device has proved very effective in the measurement of draft at various points in a boiler setting and has been checked against an impact tube. The impact tube was turned to give the maximum attainable reading, so that it presumably faced up stream in the gas flow; it was then turned to the position giving the minimum reading, presumably facing down stream, and the average of these two readings was taken to be the static pressure. This square tip made up with wire gauze gave a closer approximation to the average of these two impact tube readings than any of the numerous forms of draft tips that were tried.

The test code for steam turbines under preparation by the A.S.M.E. provides that the exhaust pressure in a steam turbine shall be measured by means of mercury columns, each connected to a static pressure hole, normal to the inner wall of the conduit and not smaller than $\frac{1}{2}$-in. standard iron pipe size. It is required that there be approximately one such hole and gage for each 16 sq.ft. of exhaust conduit area, but in no ordinary case less than two or more than six gages. The pressure holes are to be distributed as uniformly as possible around the periphery of the conduit.

In order to check these three methods of measuring exhaust pressure, a 50,000-kw. turbine operating in the Trenton Channel plant of the Detroit Edison Company was equipped, as indicated in Fig. 2, with one square tip, two British tips and six A.S.M.E. tips.* Each of these was connected to a manifold, to which was also connected a well-made mercury column vacuum gage filled with freshly boiled mercury, and all precautions were taken to secure accurate readings. These were

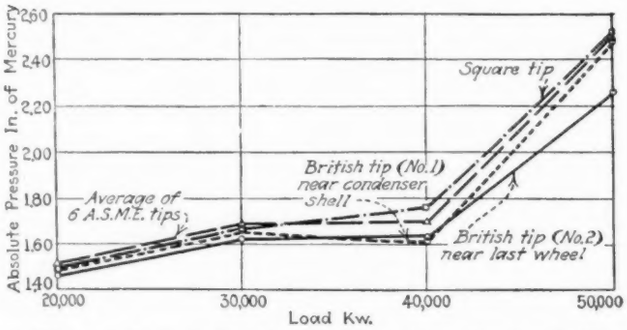


Fig. 3—Gage indications for the three kinds of tip

corrected for gage temperature and subtracted from similarly corrected mercury barometer readings.

Fig. 3 shows the readings obtained from the several tips at various loads on the turbine. The British tip, No. 2, located near the center of the exhaust passage, departs from the others rather seriously at the highest point. The discrepancy of $\frac{1}{4}$ in. of mercury is far from negligible. At the point taken at 40,000-kw. load the greatest discrepancy is approximately 0.15 in. of mercury between the two British tips, which agree, and the square tip. The average of the six A.S.M.E. tip observations seems to agree well with an approximate average of the others. At lower readings the average of the A.S.M.E. tip seems to be slightly high.

On the whole, it seems safe to say that this rather small contribution to the evidence on this subject indicates that the A.S.M.E. test code method for measuring exhaust pressure is preferable to either the British tip or the square wire gauze tip. The measurement of this quantity is attended with very great difficulty, and it is to be hoped that continued investigation will lead to the development or selection of a method that can be shown to be dependable.

*[It will be noticed that the so-called A.S.M.E. connections in this test were made with $\frac{3}{4}$-in. pipe, whereas the A.S.M.E. Power Test Codes require pipe not smaller than $\frac{1}{2}$-in. standard iron pipe size. Since the object of this requirement is to reduce the danger of slugs of water "hanging" in the gage connections and since in this test precautions were taken to avoid this, the deviation in dimensions is probably not significant.—Editor.]

Keeping Cost in a Small Power Plant

This is an account of how a small power plant not only makes use of recording instruments, but of greater importance, keeps a daily cost sheet. The chief engineer knows each morning the cost of producing steam and electrical energy during the previous day.

AMONG engineers in charge of small plants there is a prevailing belief that although it is desirable to keep cost in a large central station, it is not only not necessary but impossible to do this in a small plant. If records are worth while where operation is almost automatically controlled, they are still more valuable in the smaller plants, where a failure on the part of the fireman to carry out the proper boiler-room procedure may cause steam costs to be doubled. Records also tend to keep the force on its toes in an endeavor to keep down these costs, for when set down on paper the items at once reveal who has been remiss and when.

The North Carolina School of Agriculture and Engineering, Raleigh, N. C., maintains a power plant to supply light, power, steam heat and hot water to the several buildings on the campus. This plant has water-tube boilers, a 200-kw. non-condensing steam turbine and other machinery. It is provided, in addition to the usual gages, etc., with various recording and indicating instruments listed in Table 1, through which the plant's operation is studied.

TABLE 1—PLANT INSTRUMENTS

Steam-flow meters on boiler outlets.
Steam-flow meters on turbine.
Steam flow meters on steam-heating lines.
Steam-temperature and steam-pressure recorders on steam header.
Feed-water temperature recorder at heater.
Feed-water flow meter, recording, at heater.
Draft-pressure recorder on uptake.
Flue-gas temperature recorder.
Hot-water temperature recorder.
Coal scale.

Since all of the three boilers have flow meters on their steam outlets, it is an easy matter to discover when one of the boilers is loafing, or when one of them is overloaded, or if there are too many boilers on the line. The flue-gas temperature recorder and the steam-temperature recorder show how the fireman is handling the air supply. Each instrument is called upon in checking the operation of the plant.

The charts are collected each morning, and the boiler-room report, shown in Fig. 1, is turned in by the fireman when going off his shift. The time sheet, shown in Fig. 2, is filled in by the engineer at the end of the day.

The chief engineer goes over the readings of the instruments and then works up his daily cost in a few minutes. His cost sheet is 8x10 in. and is reproduced

BOILER ROOM REPORT
POWER PLANT, N. C. STATE COLLEGE

FROM 7:30 A M TO 2:00 P M DATE 1-16-26

BOILER No. 1		BOILER No. 2		BOILER No. 3	
COAL LBS.	TIME	COAL LBS.	TIME	COAL LBS.	TIME
1260	8:00	1240	8:08		
2530	9:55	2545	10:00		
2545	11:23	2585	11:20		
1285	1:25	1300	1:20		
BLOWN DOWN		BLOWN DOWN		BLOWN DOWN	
TUBES BLOWN	9:15	TUBES BLOWN	10:30	TUBES BLOWN	
GRATES DUMPED	7:45	GRATES DUMPED	8:18	GRATES DUMPED	
WIND BOX PRESSURE		WIND BOX PRESSURE		WIND BOX PRESSURE	
DRAFT OVER FIRE		DRAFT OVER FIRE		DRAFT OVER FIRE	
UPTAKE DRAFT		UPTAKE DRAFT		UPTAKE DRAFT	

John Williams

Fig. 1—Firemen's log

TIME SHEET
POWER PLANT, N. C. STATE COLLEGE

WEEK ENDING

SUN | MON | TUE | WED | THU | FRI | SAT | Total Hours | RATE | AMOUNT

FIREMAN

C. P.

MORNING ENGINEER

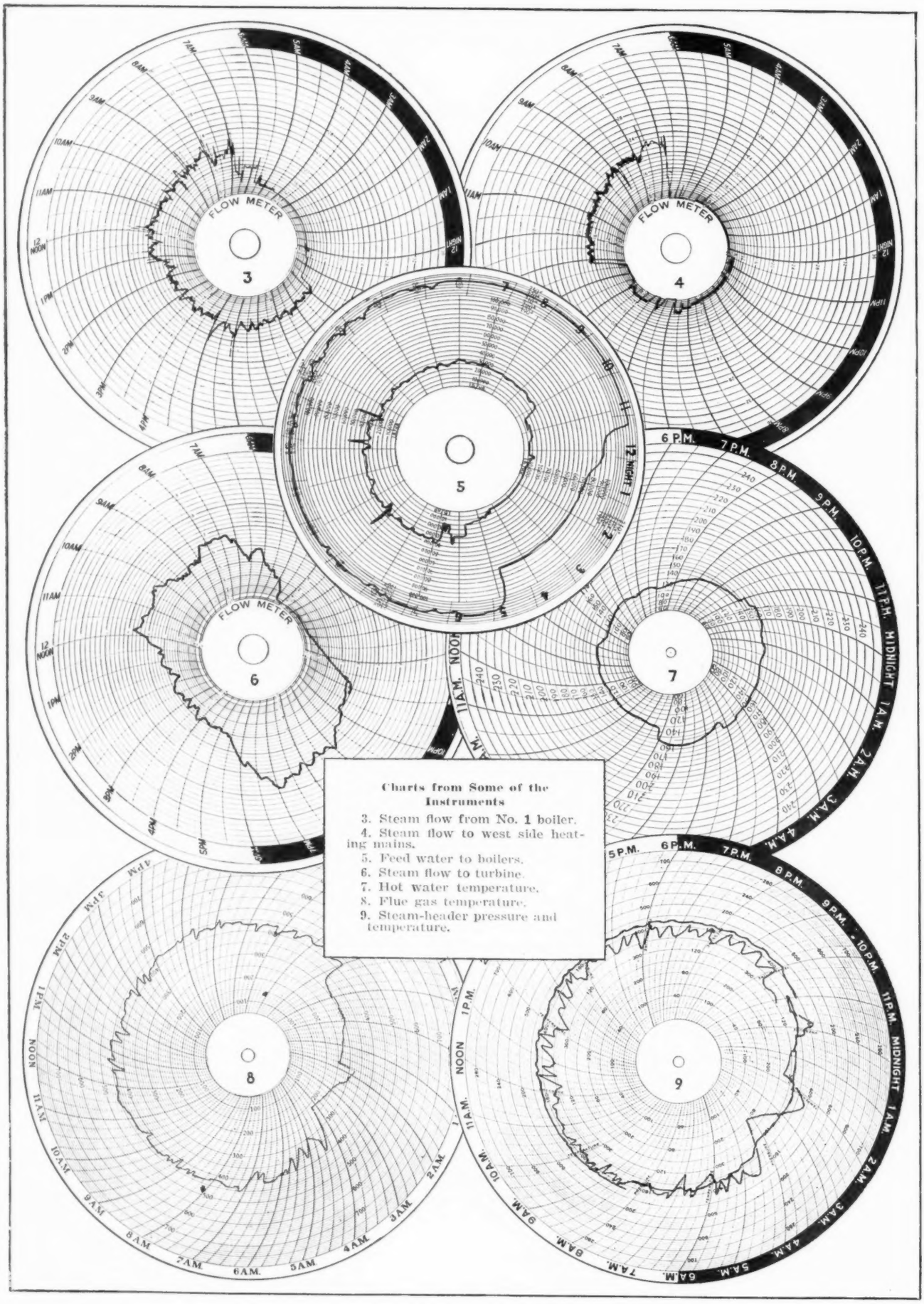
NIGHT ENGINEER

OILER

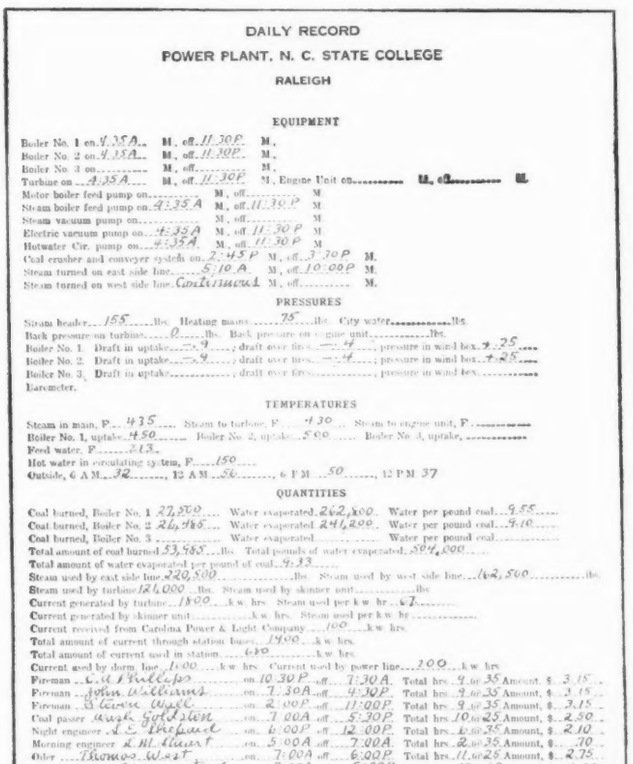
POWER PLANT REPAIRS

STEAM HEAT REPAIRS

Fig. 2—Daily time sheet


FLOW METER
3
FLOW METER
4
5
FLOW METER
6
7
8
9
Charts from Some of the Instruments
3. Steam flow from No. 1 boiler.
4. Steam flow to west side heating mains.
5. Feed water to boilers.
6. Steam flow to turbine.
7. Hot water temperature.
8. Flue gas temperature.
9. Steam-header pressure and temperature.

to a scale in Fig. 10. It will be noted that the steam-header pressure given in Fig. 10 was 155 lb. gage, whereas the heating main pressure was lowered to 75 lb. by passing through reducing valves. Under the heading "Quantities" are placed the coal used, water evaporated, pounds of steam per pound of coal, steam to turbine, steam to heating main, etc. There is also included the pay of the men working in the plant.



DAILY RECORD

POWER PLANT, N. C. STATE COLLEGE

RALEIGH

EQUIPMENT

Boiler No. 1 on 4:35A M, off 11:30P M,
Boiler No. 2 on 4:35A M, off 11:30P M,
Boiler No. 3 on M, off M,
Turbine on 4:35A M, off 11:30P M, Engine Unit on M, off M
Motor boiler feed pump on M, off M
Steam boiler feed pump on 4:35A M, off 11:30P M
Steam vacuum pump on M, off M
Electric vacuum pump on 4:35A M, off 11:30P M
Hotwater Cir. pump on 4:35A M, off 11:30P M
Coal crusher and conveyer system on 2:45P M, off 3:30P M
Steam turned on east side line 5:10A M, off 10:00P M
Steam turned on west side line Continuous M, off M

PRESSURES

Steam header 155 lbs. Heating mains 75 lbs. City water lbs.
Back pressure on turbine 0 lbs. Back pressure on engine unit lbs.
Boiler No. 1. Draft in uptake 9; draft over fires —.4; pressure in wind box .25
Boiler No. 2. Draft in uptake .9; draft over fires —.4; pressure in wind box .25
Boiler No. 3. Draft in uptake ; draft over fires ; pressure in wind box
Barometer.

TEMPERATURES

Steam in main, F. 435 Steam to turbine, F. 430 Steam to engine unit, F.
Boiler No. 1, uptake 450 Boiler No. 2, uptake 500 Boiler No. 3, uptake,
Feed water, F. 213
Hot water in circulating system, F. 150
Outside, 6 A M. 32, 12 A M. 36, 6 P M. 50, 12 P M. 37

QUANTITIES

Coal burned, Boiler No. 1 27,500 Water evaporated 262,500 Water per pound coal .9.55
Coal burned, Boiler No. 2 26,485 Water evaporated 241,200 Water per pound coal .9.10
Coal burned, Boiler No. 3 Water evaporated Water per pound coal
Total amount of coal burned 53,985 lbs. Total pounds of water evaporated 504,400
Total amount of water evaporated per pound of coal 9.33
Steam used by east side line 220,500 lbs. Steam used by west side line 162,500 lbs.
Steam used by turbine 124,000 lbs. Steam used by skinner unit lbs.
Current generated by turbine 1800 k.w. hrs. Steam used per k.w. hr. 67
Current generated by skinner unit k.w. hrs. Steam used per k.w. hr.
Current received from Carolina Power & Light Company 100 k.w. hrs.
Total amount of current through station buss 1900 k.w. hrs.
Total amount of current used in station 635 k.w. hrs.
Current used by shops, line 1100 k.w. hrs. Current used by power line 200 k.w. hrs

Fireman	C. A. Phillips	on 10:30P	off 7:30A	Total hrs. 9 @ 35	Amount, $ 3.15
Fireman	John Williams	on 7:30A	off 4:30P	Total hrs. 9 @ 35	Amount, $ 3.15
Fireman	Oliver Wyke	on 2:00P	off 11:00P	Total hrs. 9 @ 35	Amount, $ 3.15
Coal passer	Wash Goldston	on 7:00A	off 5:30P	Total hrs. 10 @ 25	Amount, $ 2.50
Night engineer	J. C. Shepard	on 6:00P	off 12:00P	Total hrs. 6 @ 35	Amount, $ 2.10
Morning engineer	L. M. Hurst	on 5:00A	off 7:00A	Total hrs. 2 @ 35	Amount, $ .70
Oiler	Thomas West	on 7:00A	off 6:00P	Total hrs. 11 @ 25	Amount, $ 2.75
Repair mechanic	E. W. Winstead	on 7:00A	off 5:30P	Total hrs. 10 @ 60	Amount, $ 6.00

Total amount of coal burned 53,985# @ $ 4.00 per ton. Total, $ 107.97

Total operating expenses, $ 131.47

Fig. 10—Daily operating cost

Several of the men are students working on part time, both to help pay their way through college and to acquire plant expierience.

The daily record permits the cost per 1,000 lb. of steam evaporated to be compared with the cost on previous days. Although the costs are not charged against the respective services at present, the chief engineer has this worked out and plans to prepare a sheet to cover the segregation. It is his intention to charge each service with the total heat in the steam as measured from the make-up temperature each day. The heat return in the condensate from the heating lines will be credited to the heating system. In the case of the turbine, the live steam used will be charged and the exhaust steam used in the feed-water heater and in the hot-water tanks will be credited. Taking the data given in Fig. 10, the charges work out as shown in Table II.

In this tabulation the amount of hot water heated is only approximately correct, inasmuch as there is no water meter on this service. There is a slight error in the make-up water amount, for the condensation of exhaust used to heat the make-up would naturally reduce the amount of make-up as computed; the error is insignificant. The steam-heating service is charged

TABLE II—COST OF SERVICE

	Items	Turbine	Heating	Hot Water
1.	Steam pressure, lb. gage	155	.....	.....
1A.	Steam pressure, lb. gage	.....	75	.....
2.	Steam supplied, lb.	121,000	.....	.....
2A.	Steam supplied, lb.	.....	383,000	.....
3.	Steam temperature	435	.....	.....
4.	B.t.u. per lb. (from 60 deg. F.)	1,206	1,206	.....
5.	B.t.u. supplied (items 2 × 4)	145,926,000	.....	.....
5A.	B.t.u. supplied (items 2A × 4)	.....	461,898,000	.....
6.	Hot water, lb.	.....	.....	374,850
7.	Hot water temperature, deg. F	.....	.....	150
8.	B.t.u. added to water, per lb.	.....	.....	90
9.	Total B.t.u. added to hot water (items 6 × 8)	.....	.....	33,736,000
10.	Exhaust to heat water, lb. (item 9 ÷ 970)	34,779	.....	.....
11.	Heating returns temp., deg. F	.....	150	.....
12.	B.t.u. in returns, per lb.	.....	90	.....
13.	B.t.u. total in returns (items 12 × 2A)	.....	34,470,000	.....
14.	Feed-water temperature, deg. F	.....	213	.....
15.	B.t.u. added to returns in heater [items (14 — 11) × item 2A]	.....	24,129,000	.....
16.	Exhaust to heat returns, lb. (item 15 × 970)	24,875	.....	.....
17.	Make-up, approx., lb. [(items 2 + 2A) — (items 2A + 16)]	96,125	.....	.....
18.	B.t.u. added per lb. make-up (213 — 60)	153	.....	.....
19.	B.t.u. added to make-up, total (items 18 × 17)	14,707,125	.....	.....
20.	B.t.u. chargeable to turbine, approx. (items 5 — 9 — 15 — 19)	73,353,000	.....	.....
21.	B.t.u. chargeable to heating (items 5A — 13)	.....	427,428,000	.....
22.	B.t.u. chargeable to hot water (item 9)	.....	.....	33,736,000
23.	Per cent of total	13.7	80	6.3
24.	Coal chargeable	$14.79	$86.39	$6.80
25.	Labor	$3.22	$18.80	$1.48
26.	Cost of service	$18.01	$105.19	$8.28
27.	Cost per kw.-hr. and per 1,000 lb. steam	1	27.4	.....

with all the boiler-room labor, as all would be used, even though the turbine was not in operation. The turbine has been charged with the engineers' and the oiler's pay.

The computation of the cost can be done in a few minutes after the various meter readings are set down. It is apparent that the energy developed by the turbine operating non-condensing is very low. This, however, would not apply during the non-heating season, and consequently the plant is shut down during the summer.

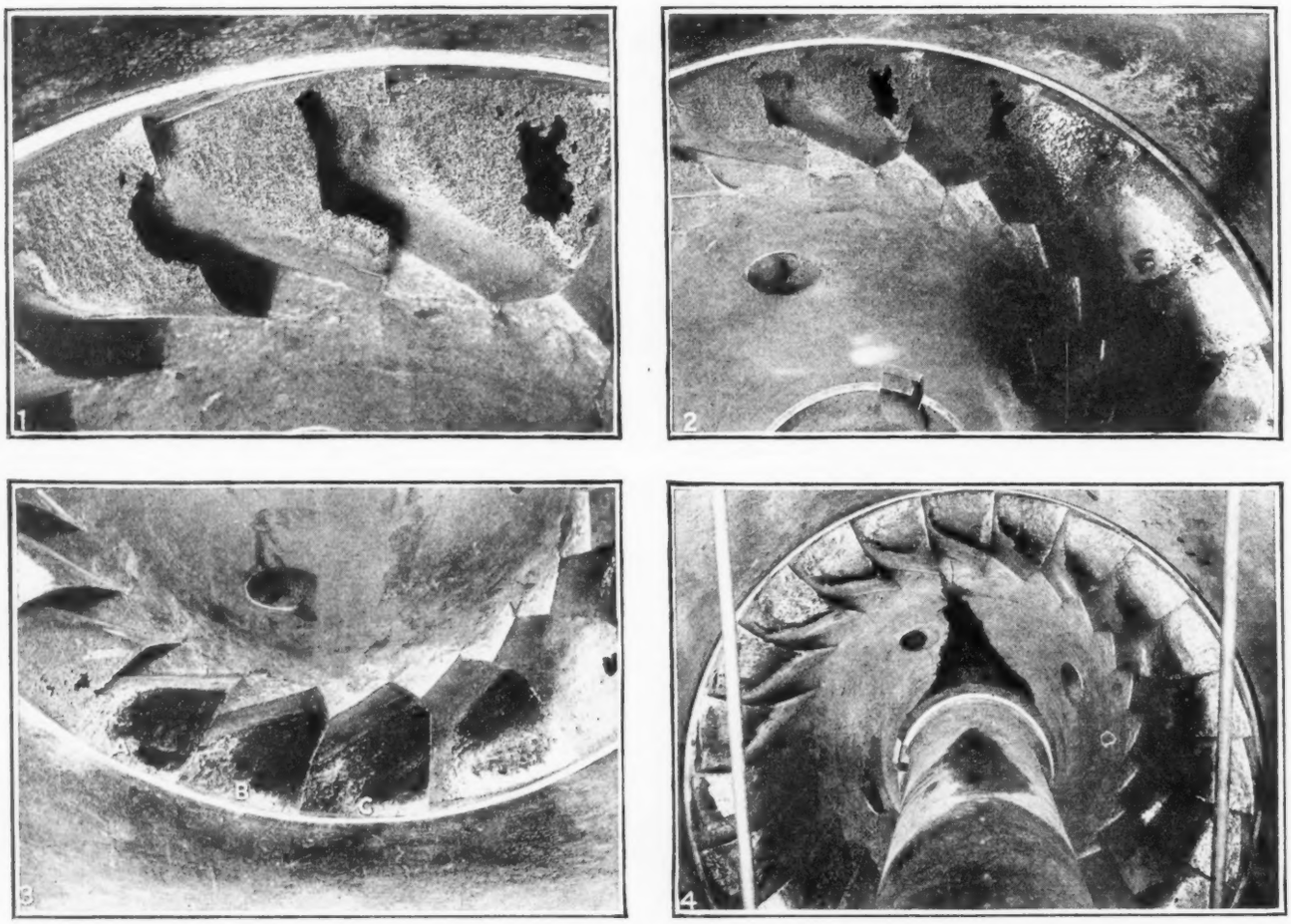
Repairing Waterwheels by Electric Welding

By C. R. Reid*

THE runner buckets of a 10,000-hp., horizontal-shaft double-runner Francis-type turbine, which had been in service some 16 years, had become badly eroded, as shown in Figs. 1 and 2. The erosion on the buckets, as may be seen, was confined to the curved portion at the draft tube end of the runner. This erosion was all on the back of the bucket, the front remaining smooth until the erosion broke through from the back. It was apparent that the curvature of the bucket was too great at this point, causing the stream of discharging water to leave the surface and the formation of an eddy with consequent erosion.

These runners are of cast steel, and it was decided that they could be satisfactorily repaired by electric welding. A platform was rigged to cover the draft tube, and three buckets were repaired in such a way as to give reduced curvature to the part subject to erosion. These are shown at *A*, *B* and *C* in Fig. 3. Three buckets were also repaired in accordance with the original pattern. The turbine was then put in service and kept running for two months. Inspection

*Power-house superintendent, Shawinigan Water & Power Co., Shawinigan Falls, Quebec.



Figs. 1 to 4—Horizontal-shaft turbine runners before and after welding

Fig. 1—Condition of inboard turbine runner before welding. Note that the buckets have been completely eroded through on the discharge edges. All of the erosion took place on the back side of the buckets. Fig. 2—Outboard turbine runner partly welded. The welded buckets are shown on the right. The condition of the buckets before repairing in the upper part of the photograph shows that they were in about the same condition as on the inboard runner. Fig. 3—Buckets *A*, *B* and *C* on outboard runner were repaired with reduced curvature and three others according to the original pattern, and the turbine run for two months before deciding to repair the buckets to their original form. Fig. 4—Inboard runner after welding and grinding. Ground carbon blocks were used to obtain the proper shape of the buckets during welding.

then failed to disclose any sign of erosion on either from of bucket. It should be noted that two years ago the tailrace level was raised some five feet with a resultant reduction of the draft head on the turbine by this amount. This increase in tailwater level was brought about when a new plant was put into service farther down the river. It is believed that this reduced draft head will greatly reduce the erosion, if not entirely eliminate it. The total operating head is now 145 ft., instead of 150 ft. as originally.

Since the cost of restoring the buckets to the original form was approximately one-half as much as to change to the modified form, it was decided to make the repair without altering the form. The repairing was done in eleven days, including the time required to install and remove the scaffolding twice. The turbine was put in service and operated for a few days before the job was completed.

The cost of repairing the 42 buckets on the two runners, without taking into consideration the six that had been previously repaired, was as follows:

Labor	
Welding, grinding scaffolding	$222.00
Material:	
160 lb. welding rod	33.00
Scaffolding lumber	20.00
Total cost	$275.00

Since there were 42 buckets, this makes the cost per bucket approximately $6.55.

The welding was done by one man working twelve hours a day. A direct-current arc of 175 amperes was used with a $\frac{5}{32}$-in. welding rod. Carbon blocks were ground to the shape of the inside of the bucket, and the welding was done with these blocks as a form to work against. The welder's helper swaged each course of welding as it was put on in order to remove contraction stresses. Sufficient ventilation was secured through two manholes in the wheel case. The finished job on one runner is shown in Fig. 4.

THE TREATMENT OF BOILER-FEED WATER, to prevent or modify scale formation and to eliminate corrosion, is a complicated subject involving a range of physical and chemical knowledge beyond that of most engineers. Under the joint auspices of the American Water Works Association, the National Electric Light Association, the American Railway Engineering Association and the American Society of Mechanical Engineers, a group of nine committees is actively engaged in studying the subject from various points of view. It is hoped that some of the obscurity surrounding the subject will be cleared up.

Facts Needed from Which to Draw Conclusions

SIMULTANEOUSLY with a proposal by New York State to contribute its Barge Canal to an all-American waterway between the Great Lakes and the Atlantic comes an address from Secretary Hoover before the John Ericsson Republican League of Chicago on "The Waterways Outlet from the Middle West," emphasizing the importance of waterway development. At his suggestion, two years ago we entered into an agreement with the Canadian Government for a joint and conclusive investigation of the St. Lawrence route. United States engineers are also making a comprehensive engineering review of the shipway route across New York State. The results of these two investigations will be completed within a few weeks. Secretary Hoover says: "Until we have the complete engineering data whereby we can compare the cost of construction and the advantages in operation of the two routes, it is useless to enter upon debate as to their comparative merits. When we have the facts and conclusions in hand, we can then hammer them out on the anvil of debate."

This debate will be followed with interest by those who are concerned with the possibilities involved in reducing to service to humanity the four million continuous horsepower developed in the fall of the output from the largest water-storage system in the world from the level of Lake Ontario to that of the sea.

Self-Examination for Teachers

IT IS a strange phenomenon that some teachers who have given their lives to the study of science and are fully convinced of the importance of a scientific analysis of all data in their chosen field—whether economics, mechanical engineering or physics—seem indifferent or even hostile to any attempt to judge the effectiveness of their teaching by the same unbiased standards. All of us are prone to accept the superstition that our own particular jobs are best handled by the aid of some mysterious "hunch" and must forever defy cold-blooded analysis.

Fortunately, not all teachers are of this type. Many are open minded enough to accept the results observed in examination papers as a measure of their own efficiency as well as that of the students.

The Taylor Society has recently issued—in a form suitable for framing—a set of eight "Principles of Teaching," these being an outline of a recent address by Paul H. Hanus, Professor of Education, Emeritus, Harvard University. Stripped of their explanatory comments, these are:

I. In my teaching, are my aims, ultimate and immediate, clear in my own mind?

II. Do I avoid talking too much or too little?

III. Do I make appropriate use of the students' previous experience and instruction?

IV. Do I make good use of illustrative material?

V. Am I sure that my students react vigorously to my instruction?

VI. Are most of my students usually interested in the classroom work?

VII. Do I habitually read the best contemporary literature in my field?

VIII. What tests do I employ to assure myself that my students are achieving the results at which I aim?

The teacher who will examine this list, principle by principle, at frequent intervals and take steps to correct the shortcomings so revealed, cannot fail to increase his effectiveness.

The Industrial Plant's Engineer

POWER PLANTS for industrial concerns seem to be receiving more attention than has been customary in times past, if one may judge from the number of discussions that have recently been presented dealing with such stations. Naturally the operating engineers came in for some comment in these discussions. Probably the most significant statement is that of Mr. W. H. Larkin in his paper on "The Supply of Industrial Power" abstracted some time ago in *Power*, where he says:

> The day of the old-fashioned engineer who knew very little of theory and cared less is long past. The cost of fuel is too high for indifferent and careless operation, and inefficiency has too great an effect on the cost of production to pass unnoticed.

This single statement contains a whole sermon to operating engineers, and particularly to the younger men. Those who would succeed in their chosen vocation must take advantage of every opportunity to study theory and power-plant accounting and furthermore must put these studies into practice. There is little excuse for not undertaking such studies, with excellent correspondence courses and night schools available to all who would learn.

The industrial power plant will withstand absorption by the central station only when it can furnish service at a lower over-all cost. Conditions are such in many cases that very large savings can be made in the operation of industrial plants, as for instance in the utilization of waste heat, that might be effected by a competent operating man. The central stations have taken large numbers of college men into their service, have trained them in practical operation and have then paid them substantial salaries to put their theories into effective use, materially reducing the cost of power. The industrial plants with a few exceptions have not availed themselves of this source of raw material. They might do so greatly to their own advantage. In fact a central-station operator recently remarked that the central stations would have more difficulty taking over industrial plants if these concerns had competent consulting power-plant engineers or employed $10,000 a year engi-

neers in charge of power production in their plants. When this fact is more fully appreciated by our hard-headed business men, there will be more and greater opportunities in industrial plants for the operating engineer who knows his theory well and can get results out of a plant.

Second-Hand Equipment

SECOND-HAND AUTOMOBILES sell for less than new. The same applies to furniture, except where it is sufficiently second-hand to be called antique; then it sells for more. This whole question of the relative value of things new and used is an interesting study entirely apart from practical considerations, but the practical value of a real understanding of such matters is considerable.

Sometimes it is hard-headed economy, for example, to buy a piece of second-hand power equipment. At other times it is the height of folly. In determining which description applies, one must consider not only cost and working condition of the equipment but also its suitability to the work at hand. An engine, to take a piece of equipment frequently placed on the second-hand market, must be of the right size and designed for the given steam conditions if it is to be a good purchase. Engines much too large or too small for the loads they normally carry are notoriously inefficient. Except where efficiency is immaterial, as in certain industrial plants where the heating load far exceeds the power load, this point must be carefully considered. The advertisement may read "300-hp. Corliss Engine in Good Working Order." It may well be in good working order—well-cared for engines depreciate very slowly—but that does not prove its suitability by a long shot. If the installation of this particular engine will increase the plant steam consumption (compared with a new uniflow) four million pounds per year, as it might easily do, the old engine would be a bad bargain at any price.

Interconnection of Transmission Lines

DURING the water shortage in the South last year, the interconnection of the several transmission lines permitted the heavily loaded systems having a water shortage to obtain energy from systems having a slight excess of power. However, there are operating difficulties experienced that are seldom considered by those who advocate a complete tie-in of all the existing transmission systems.

It was found that the paralleling of systems while obtaining the proper transfer of energy from one to another was almost impossible. One of the Southern companies which acted as an intermediary between two others, assuming merely to deliver the excess it received from the third company, had a street-railway load that made up a considerable part of its electrical demand. If the voltage and cycles were such at a given hour as to permit the delivery of energy to the receiving company, the simultaneous starting of a number of cars would so overload the system's generating units that the cycles would drop. The third, or receiving, system's cycles and voltage would remain constant and of course energy would be pumped back into the low-cycle system. By the time the station operators, in answer to telephonic objections, had slowed down the prime movers to place the system in a position to receive energy again the street-car load would have dropped and the second system would then start pumping, probably, thirty thousand kilowatts into the third system in place of the ten thousand agreed upon. The plant operators of all the interconnected lines were kept busy regulating the prime movers' speed and balancing was most difficult.

If exchange of current is to be accomplished, the more feasible method, according to some Southern engineers who have made a study of the problem, is to tie a single plant or unit with the receiving system, disconnecting it entirely from its own system. In this way a balanced condition can be obtained and overloads avoided. This is being done at present, when, for example, a waterwheel unit in a plant containing four has been leased to another company and disconnected from its owner's system.

Engineering and Human Happiness

THIS has been called the "Age of the Engineer." His contributions to human welfare have resulted in giving the people of the United States, among many other advantages, one newspaper for every three and a half people, one automobile for every six people, electric lights and telephones in every other household, and artificial gas to every fourth family. Through the use of mechanical power to the extent of about seven available horsepower per capita our people possess far greater productive capacity and enjoy more luxuries than any other people in the history of the world.

It may be well, however, to reflect upon the effect of this position upon our philosophy of life. Are we measuring an individual's accomplishment in terms of his power over his fellow men? Do we reward mainly aggressiveness, domination and self-assertion and neglect loyalty and modesty?

We are enjoying great potentialities because of the accomplishments of the engineer, but must guard against making this a condition of happiness. The engineer should strive to use his talents in order that man may have more and cheaper power, better systems of transportation and of communication, better cities, and more practical methods for heating and cooling buildings. He should strive to create and to construct. He should use his talents to stimulate human effort and accomplishment, but should constantly have as his main goal the common good. The wisdom must be his to utilize the new forces that he is continuously creating for the insurance of true human happiness and the permanency of our civilization.

Many strange ideas are afloat. One of the strangest still persists among dye-house workers and foremen. Perhaps it is their knowledge of the vast difference between yarns of virgin wool and those of reworked material that leads them to object to "second-hand" steam. To many of them steam that has generated power has had the life taken out of it and is not suitable for heating dye kettles. No amount of argument or even of demonstration will make them believe that low-pressure steam will do the job just as well.

The British Coal Commission has issued its report. No nationalization! No subsidies! Government should own all mineral deposits, granting to private enterprise concessions for working them. The control of prices and profits would then rest with the public and there would be no unearned increment.

Practical Ideas From Practical Men

Aluminum Paint Causes Trouble in Transformer Oil

A customer recently returned to the manufacturer some samples of oil taken from a transformer that had failed. The oil had been found dirty, and seemed to carry a large amount of black sediment for which the customer could not account. Analysis of the oil showed small quantities of aluminum, for which the laboratory could give no explanation. The findings were reported to the customer, with a request for a possible explanation of the aluminum.

The matter was cleared up in a letter from the customer to the manufacturer which read:

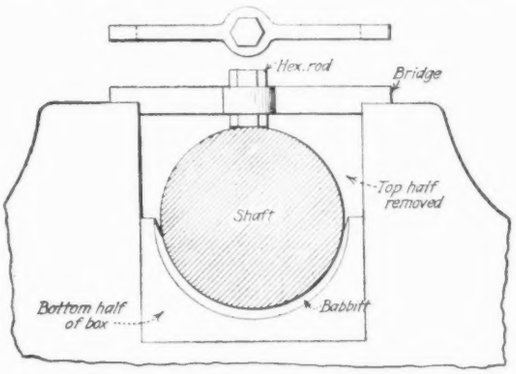
"The surprising results which you found, showing aluminum in the oil, is undoubtedly from the fact that we painted the transformer tanks in the building with aluminum paint, using a paint spray. This no doubt saturated the atmosphere in the building with aluminum, which was taken into the transformers through the breathers.

"This analysis has therefore given us a very valuable suggestion, and in the future we will see to it that the breathers are closed when aluminum paint, or any paint with a spray, is used."

GUY BARTLETT,
Schenectady, N. Y. General Electric Co.

Gage for Checking Wear on Crankshaft Bearings

A useful and simply made gage for determining the alignment of a heavy or for that matter a light vertical type of engine can be made as follows: A bridge made by welding two arms to a piece of metal about 2 in. in diameter is fitted with a recess on the under



Gage gives a ready check on amount of wear in each bearing

side so that it is an accurate fit across the bearing as shown in the illustration. A hexagon hole about 1 in. across the flats is then made in the center of the bridge and a piece of hexagonal rod is fitted to it. To use the gage the bridge is placed across the top of the gap with the top box removed and the rod is slipped into the hole and allowed to rest on the top of the shaft.

The other end of the rod projects through the bridge, and on one side of the rod a mark is made flush with the top of the bridge and is a permanent record of the height of the shaft above the lower block.

In order that there shall be no confusion with other bearings, a reference number should be stamped on the flat and a similar number on the bearing. The same procedure is taken with all the other bearings of the engine, and marks made on the corresponding flats of the rod. As the recess or gap that takes the blocks is usually machined at the same time and with the same cut, this gage is used to check the difference between bearings as well as for making a periodical independent check on each bearing to ascertain the amount of wear in the babbitt of the bottom box over that period.

MAURICE C. COCKSHOTT.
Hollywood, Calif.

New Pump Plunger Eliminates Breakages

The use of high boiler pressures in power plants where the auxiliaries are designed for lower pressures often causes operating difficulties. In one plant the

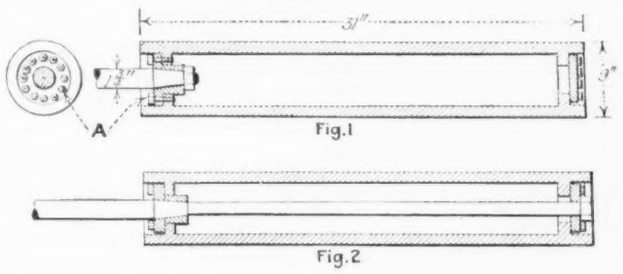


Fig. 1—Plunger which gave trouble. Fig. 2—New design of plunger and rod

boiler-feed pump was a 14x9x10-in. unit. As the total water used per day was more than 1,000 tons and the pumping pressure 180 lb. per square inch, the stress on the pump parts was considerable and it was decided to cast about for some means to reduce it.

The forward end of each plunger was provided with a separate head having a taper bore into which the tapered end of piston rod was drawn up by a large nut, as illustrated in Fig. 1. This head was secured to the plunger by a circle of ½-in. stud bolts as shown at *A*. The pump had been in service but a short time when these ½-in. studs broke on one plunger. New stud bolts were put in, and a week later the same happened on the other plunger. It was decided then to drill the holes larger and tap them for ⅝-in., capscrews being substituted for the steel bolts. A little later the first plunger again tore loose and it also was repaired with ⅝-in. capscrews. Shortly after this the first ⅝-in. capscrews again pulled off and ⅝-in. stud bolts were screwed in

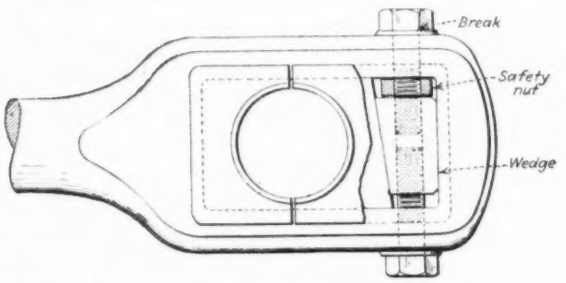
tight, but these stud bolts all pulled off and larger tapings could not be made, because there was not sufficient metal between the holes.

The last break demolished the plunger in such a way that a new one had to be ordered, so two were procured with the piston rods passing through the interior of plungers, with the large nuts against the back heads as shown in Fig. 2. Since these new plungers and rods were placed in the pump no further trouble has been encountered. ANTHONY A. FETTE.

Cincinnati, Ohio.

Safety Block for Crankpin Bearing Adjusting Wedge

Recently the top wedge bolt in the crankpin brasses on a 15x18-in. engine broke just under the head, as indicated in the accompanying sketch. I did not hear the bolt head hit the crankcase as it flew off, but a rapidly increasing pounding caused me to hurry to the



Safety nut keeps adjusting wedge in place when bolt breaks

engine and shut it down. On opening the crankcase I was amazed at the distance to which the lower bolt had backed out in the short time during which the jamb effect of its mate was lost. Had I been out of the engine room at the time, considerable damage might have been done to the engine.

Years of wear had lowered the wedge block to the low position shown in the sketch, so when I put in a new top bolt I fitted a nut into the space between the top of the wedge and rod-end. This safety nut is a neat fit on the bolt thread, and now the engine is safe no matter where either of the bolts break.

Vancouver, B. C. R. MANLY ORR.

Causes of Turbine Vibration

One of the common causes of turbine vibration is a slightly bowed shaft. When a turbine is operating normally, the portion of the shaft in each stage is at a different temperature, starting with a high-temperature in the first stage and graduating down to a fairly low temperature in the last stage, where the vacuum is high. When the turbine is shut down, the heat equalizes along the shaft, but the bottom half cools more rapidly than the top half, due to the heat of the turbine being bottled up in the top half of the wheels and casing. Thus the lower half of the shaft contracts more rapidly than the top half, or in the case of a leaky throttle or gland-sealing valve, the top half would elongate more rapidly than the bottom half; either condition will cause the shaft to be bowed slightly. If the turbine is started up quickly or before the shaft has a chance to be heated up evenly all around, it will cause vibration.

This is more noticeable as the sizes of the turbine increase. If a 20,000- or a 30,000-kw. turbine is shut down for an hour and then started up quickly, it will run rough, often having to be shut down and started all over again; during this time the heat has had a chance to equalize around the shaft and it will then run true.

It is a good plan to give a turbine plenty of time to warm up, by starting slowly and marking the opening of the throttle that will bring the machine up to speed in $\frac{1}{2}$ to $2\frac{1}{2}$ hours, depending on the size of the turbine. The 5,000-kw. turbine in the station I now have charge of is set for $\frac{1}{2}$ hour, which seems to be about right, whereas the 10,000-kw. machine requires a little longer. I understand it requires $2\frac{1}{2}$ hours to bring a 30,000-kw. turbine up to speed; although they are often started much faster in cases of emergency, this practice is sometimes followed by results that are unfortunate, to say the least.

I once had charge of a station where the 5,000-kw. turbine was shut down at 1 a.m. and started again at 5 a.m. This was a regular operation on a street railway system. One morning the engineer started the turbine as usual, but it vibrated so badly that it shook the covering off the steam pipe and the hands off the oil gages on the front of the machine. Although I was not present at the time, I saw the results. As we had only the one turbine, it was shut down and restarted and came up to speed perfectly, as it did all the remainder of the time I was in that station, without showing a sign of further vibration. I believe the shaft was bowed by unequal expansion when first started, but the time taken in shutting down and starting all over again had given the shaft a chance to become evenly heated and straighten out.

I should like to hear through *Power* from other central-station engineers their experiences in starting up turbines and causes of vibration. F. B. WHEATON.

East Bridgewater, Mass.

Boilers Would Not Steam

In a plant containing five 10,000-sq.ft. boilers the breeching was below the boiler-room floor and the boiler downtakes, which were of steel, entered this breeching at the top. After the plant was placed in operation it was found that if forced to above, say, 200 per cent rating, the boilers refused to carry the load, smoke poured out through the stoker fronts and a positive pressure built up in the furnaces.

Repeated trials proved that the trouble was not imaginary, and the job was to find out why this happened. After going over the entire settings, both with and without a load on the units, it was discovered that when the boilers were forced, the steel smoke connection bulged in as much as 3 in. The connection was about 20 ft. long and 22 in. wide, and the concaving of the sides gave an area insufficient to pass the gases. There had been no allowance made for expansion of this 20-ft. steel connection where it entered the breeching and when the gases increased in temperature as the load increased, the lengthening of the steel sides resulted in concaving. The trouble was remedied by making the openings into the breeching longer than were the smoke connections. CHARLES FIRST.

Jacksonville, Fla.

Comments from Readers

Hydrogen in Fuel

I was very much interested in the comment of C. B. Hudson in the Feb. 23 issue on burning low-grade coal. If I understand his letter, he claims that little or none of the hydrogen contained in fuel is beneficial in boiler operation. The fuel oil with which he is familiar contains 11 per cent hydrogen and most likely 84 per cent carbon and 2.88 per cent oxygen. From the heat-value formula

$$C\ 14{,}600 + \left(H - \frac{O}{8}\right)\ 62{,}000 = \text{B.t.u. per lb.}$$

$$0.84 \times 14{,}600 + \left(0.11 - \frac{0.0288}{8}\right) 62{,}000 = 18{,}836 \text{ B.t.u.}$$

is available in the oil, yet only 12,264 B.t.u. is contained in the carbon content.

May I ask why the hydrogen content is detrimental when it contains 6,572 B.t.u.? When 1 lb. of fuel oil is properly burned in a boiler furnace it will evaporate 14 or 15 lb. of water, whereas 1 lb. of coal containing 84 per cent carbon and 14,000 B.t.u. evaporates only 11 or 12 lb. [He evidently refers to equivalent evaporation—EDITOR.]

If this increased evaporation per pound of fuel isn't done by the combustion of the hydrogen content, what does it? W. R. MOYNAN.

North Dighton, Mass.

Filters for Air Compressors

In the Jan. 12 issue of *Power*, on page 65, under the heading "Practical Ideas from Practical Men," there appeared a contribution from G. H. Cornell on an improvised air filter for air compressors.

I would say that the method of prevention of the entering of dust and dirt into the intake of an air compressor by means of a steel wool filled box as suggested would not be practical, although some cleanliness of the air would probably result for a very short while.

The flow of air to the end of the intake which is shown covered with two thicknesses of cheese cloth would concentrate at that point to such a degree that the dust, oil and broken off particles of the steel wool that had escaped the filtering medium of steel wool would in a very short time entirely cover the cheese cloth and build up such a resistance as to be objectionable. There would be no means of preventing the oil from entering the compressor, as the air flow, being attracted to the center of the filter, would carry whatever oil that could be separated from the steel wool. There would be no means of preventing the entrance into the compressor of particles of broken steel wool that might possibly penetrate the cheese cloth, and they would prove more harmful than the dust and dirt in the absence of any air cleaner.

Steel wool, combined with oil of any viscosity, has proved to be a poor air cleaner, in that the dust and oil gum up the steel wool to such an extent as rapidly to increase the resistance. It is almost impossible to clean the steel wool satisfactorily, especially if an oil of proper viscosity to attract the dust particles is used.

The general plan of a box filter connected to the end of the intake is very good, however. The principle is used in a commercial air filter used for the cleaning of air for air compressors, internal-combustion engines, general ventilation, etc. This box filter is fitted on the end of the intake by means of a standard flange on one side. According to the capacity of the air compressor, the remaining sides are fitted with cells 20 in. square by $3\frac{1}{2}$ in. thick, each cell having a capacity that will vary according to the type of compressor, with a guaranteed cleaning efficiency of 97 per cent and a guaranteed maximum resistance of $\frac{3}{8}$ in. of water, which low resistance has no appreciable effect whatever on the efficiency of the machine. Each cell, being filled with crimped metal ferrules, about the size of 0.38-caliber cartridges, is dipped regularly in a viscous oil, usually every six to eight weeks, depending upon the surrounding atmospheric conditions. There are no parts that can wear off, and no chips or fibers that can enter the intake of the compressor. The resistance remains constant, and the cleaning is dependable. There are numerous installations of these box filters throughout the country, and all appear to be giving such satisfaction that one should hesitate before using any improvised equipment that might have a tendency to cause more harm than to do good.

I have had considerable experience with air filters on air compressors and have found that the intake of the compressor should not come in contact with any solid matter, and any cleaning equipment that might be added for air-cleaning purposes should be placed around the end of the intake, rather than adjacent to it, in order to prevent contact with the cleaning medium.

Baltimore, Md. CHARLES G. L. HUETHER.

The Large Diesel

Referring to the article entitled "The Case of the Large Diesel Engine" in *Power* of Dec. 22, 1925, it is to be regretted that an engineering paper displays a criticism on a Diesel engine which is not quite justifiable at a time when this type of engine has proved its reliability, and it is to be regretted even more, since the arguments do not agree with the facts.

The article in question states that the compression in the lower end is low and that two-thirds of the power is developed in the upper end. In reply to this statement I quote from a paper read by the designer of the Gripsholm engine, H. H. Blache, before the Institution of Engineers and Shipbuilders in Scotland (see *Proceedings* 1924-1925, page 485), which reads as follows:

"The engine works on the clear Diesel principle for top as well as for bottom—that is the inlet air is compressed to a pressure of 32 atm. and a corresponding temperature, so that the atomized oil can be ignited without the aid of red hot bodies or other means of ignition."

I may bring further proof from actual engine tests that double-acting engines, in general, develop about the same mean effective pressure on top and bottom of cylinder.

Name of Engine or Vessel	I.h.p.	Average Pressure, Top	Lb. per Sq.In. Bottom	Source of Information
Fritz	1,150	89	87	Z.V.D.I. 4.30.21
M.A.N.	10,980	107	105	Z.V.D.I. 12.22.23
Magdeburg	4,000	77.5	77.5	Z.V.D.I. 10.24.25

From these figures it is apparent that the pressure on double-acting engines is carried practically the same on top and bottom.

The great difference in readings on the various engines is explained by the fact that the test on the M. A. N. engine, for instance, was run at considerable overload; the rated load of this six-cylinder engine was 6,000 brake horsepower. The rating on the Magdeburg is low to satisfy individual specification and the engine developed on its trial trip 4,700 brake horsepower without forcing the engines; as a matter of fact, this same engine at a somewhat higher speed is operated at 6,250 brake horsepower on the "Augustus."

When the piston rod is taken into consideration, the power developed in one cylinder is 476 indicated horsepower at the top and 422 at the bottom on the engine of the Magdeburg.

How little the piston rod actually means on the effective area of the cylinder can best be judged by figures. On the Worthington double-acting engine the effective area at top is 616 sq.in. and at bottom 556 sq.in. It is to be regretted that when all these proofs are available, an engineer can make such a statement that two-thirds of the load is carried by the upper part of the cylinder and that, therefore, double-acting engines are poorly balanced.

The first paragraph of the article in question states that the history of two large units that were being built in Germany during the war do not justify great optimism. It is well known that these engines had to be destroyed on the basis of the peace treaty. Why were they to be destroyed if they were no success? Smaller double-acting engines installed in a freighter went to England as reparation payment; if they were no good, why did England want this vessel? If these engines were later removed, it was not the fault of the engines. The writer unfortunately failed to mention that the success of the "Magdeburg" was so pronounced that on the basis of it the builders, Blohm & Voss, received orders for five or six more vessels equipped with this engine and this very type of engine also goes into the power station of the City of Hamburg. Such engineering progress and courage should be encouraged and should be a guide for us in the line of engineering development.

H. SCHRECK.

Jackson Heights, N. Y.

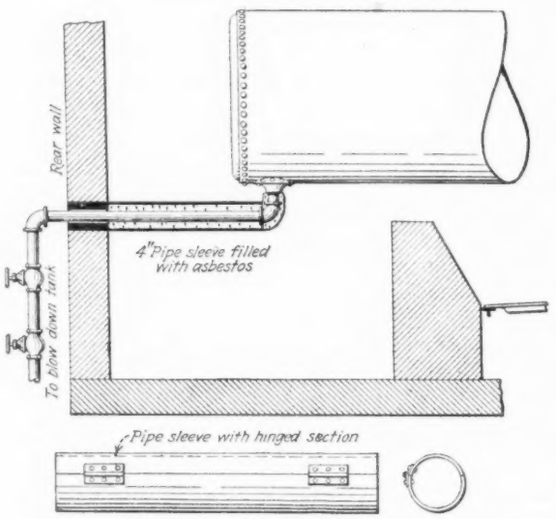
Protecting Blowoff Lines

In the Jan. 5 issue Frank E. Baliman asks for the opinion of other engineers on the plan of protecting blowoff lines. Having had considerable experience on the Pacific Coast for several years in burning the same kind of fuel Mr. Baliman is using, I would suggest that he remove the brick wall in front of the blowoff pipe, as it gives little protection to the pipe and the space between it and the bridge wall will soon fill up and lessen the volume of the combustion space. Also lower the bridge wall until the top is from 26 to 30 in. below the bottom of the drum and make the blowoff pipe with a long bend instead of an elbow.

The blowoff pipe should be covered with asbestos by first wrapping the pipe with 1-in. mesh wire netting, which will serve to hold the asbestos on the pipe. I have found this method to be satisfactory.

Wells, Ore. I. L. BABCOCK.

A method of protecting blowoff pipes that I have used with good results is shown in the illustration. A protecting sleeve made from 4-in. pipe is cut as shown in

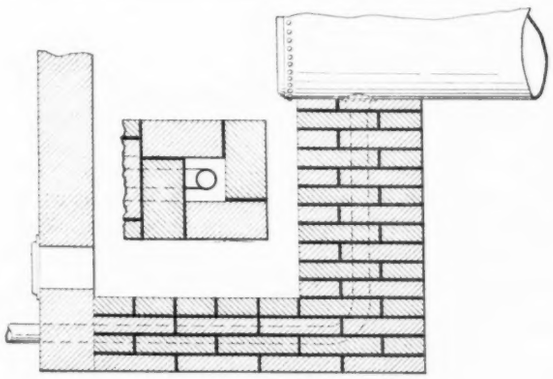


A hinged sleeve is placed over pipe and filled with asbestos

the detail, and the two pieces are hinged together. When the sleeve is in place around the pipe, it is filled with asbestos. The reason for hinging the top part of the sleeve is to permit of ready inspection of the pipe. Asbestos rope is wound around the vertical section of the pipe and plaster is used on the fittings, ordinary pipe bands being used to reinforce it.

Brooklyn, N. Y. LOUIS CUSTER.

A method I have used of protecting blowoff pipes regardless of the style of furnace is shown herewith. A brick stack is built around the pipe, giving an opening



Brick stack is built around pipe

for the pipe of about 4½ in. square. This method has given very satisfactory results.

Columbus, Ohio. L. A. COLE.

Auxiliary Drive

In the issue of July 7, 1925, C. V. Kerr defended the steam-driven auxiliary, but based his argument on an entirely false premise—namely, that if a kilowatt-hour is not diverted to the auxiliary drives, it can be sold and therefore may be charged at its sale value, which in this case has been taken as 4c. Unfortunately this is not the case; the load is fixed by conditions entirely external to the generating plant, and all that can properly be charged for this kilowatt-hour is the fuel necessary to produce it. Taking the figures used by Mr. Kerr, the value of the five kilowatt-hours becomes 5.87c., and on the same basis the cost of the 6.7 b.hp. produced by the auxiliary turbine is 8c.

The cost per 1,000 lb. of steam depends so much upon the plant load factor that it cannot properly be used as a basis of value upon which to compare different types of heat balance. In a given plant the quantity of steam produced might vary between very wide limits without changing either the investment required or the labor cost. With this in mind, it is evident that increments of steam produced are properly charged only with the fuel necessary to produce them.

In a case of a central station, devoted exclusively to the production of electrical energy, there is little doubt of the superiority of motor-driven auxiliaries supplied with power from the main generating units or from an auxiliary generator driven by the main turbine, the feed water being heated by bled steam. The thermal efficiency is better and the cost per unit of output including fixed charges is lower.

In the case of an industrial plant where there is a large demand for low-pressure steam the problem is a different one, but even here it will usually be found that motor drive may profitably be applied to a considerable proportion if not to all of the auxiliaries.

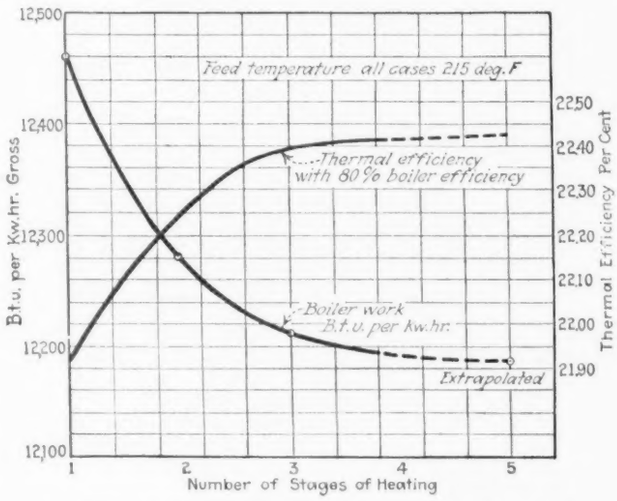
Turbines may be had from which all of the steam necessary for process, heating, etc., can be extracted. In many cases there is low-pressure steam available as a residue from process, and this may be returned to the low-pressure stages of the turbine, or if the quantity is sufficient, a special low-pressure machine may be provided to use it.

It might be of advantage in some cases to do heating with electricity in order to obtain a balance such that no steam be wasted to the atmosphere. A condition may readily be imagined wherein either the heat demand in steam is so great that its pressure reduction through a turbine would produce more power than there is use for or wherein there is a quantity of steam available as a residue from process work which would produce more power than there is use for. In this type of case a balance could be secured by transferring some of the steam heating over to electric heating.

The inherent fault in the steam-driven auxiliary system is the difficulty of maintaining an adjustment between the quantity of exhaust steam available and the demand. Various means have been used from time to time to accomplish this end, consisting usually of some combination of steam and motor drive with a means for adjusting the load between the two. The best of these systems have not proved entirely satisfactory and do not lend themselves to automatic control.

Mr. Kerr also stated that the heating of feed water by bled steam is not as efficient as with exhaust steam. This is of course not the case, as heating with bled steam always results in better economy. The curve herewith shows the heat required per kilowatt-hour when the feed water is heated to 215 deg. with all steam bled at 17 lb. absolute, which is practically equivalent to heating with the exhaust from auxiliaries, and when the same heating is done in two, three or four stages.

When the heating is done with exhaust from the auxiliaries, the miscellaneous incidental losses are somewhat higher than in the case of bleeding from the main unit, hence the efficiencies indicated for the single-stage heating are probably slightly high. The values for B. t. u. per kilowatt-hour include the heat chargeable to the turbine room only, with no allowance for boiler-room losses. In calculating the thermal efficiencies the boiler efficiency has been taken at 80. It will be noted that there is a substantial improvement between one and three stages of heating. Of course with bleeder heating the feed temperature may be carried to a much higher level, but this factor has nothing to do with the argument between steam and electric drive for auxiliaries.



Effect of increasing the number of stages of feed-water heating

The problem of type of drive for auxiliaries is not answerable to any general rule. Each case must be considered in the light of its own peculiarities.

In the issue of Jan. 26, 1926, Mr. Kerr makes some further remarks in justification of the steam turbine for auxiliary drive. He suggests placing auxiliary turbines between bleeder stages of the main turbines. Removing steam from the main unit to drive an auxiliary turbine the efficiency of which is less than that of the main turbine hardly seems a rational thing to do. The electrical losses incident to motor drive are more than compensated for by the loss of available heat in the steam carried to and used for driving the auxiliary turbine.

In order to supply any large proportion of a station's auxiliaries with steam in this manner, a specially designed turbine would be required capable of passing a large quantity of steam through the high and low-pressure sections with a decidedly reduced quantity passing in the intermediate sections. Alternating-current motor equipment is now available that will provide practically any degree of speed control desired. Slow-speed equipment can be driven by motors without gears of any kind,

whereas with a small turbine high speed is a necessity and gears cannot be avoided.

There still remains the question of reliability of motor drive, since a station shutdown would deprive all motor-driven equipment of power. As the advantages of motor drive become more fully realized, this condition will be met by means suiting the particular case in hand. The so-called "floater" turbine is a method that may be used in some cases. This consists of a turbo-generator normally running as a synchronous motor and serving as a power-factor corrective; in case of loss of power and drop in speed the throttle valve opens automatically, thus maintaining power supply to the auxiliaries. The turbine may be designed to run either condensing or non-condensing. With the modern tendency to interconnection of systems providing several incoming lines to a station, there is little need for such an emergency power supply. W. P. GAVIT.

New York City.

The Salesman's Value to the Engineer

The opportunity for practical, up-to-date consulting service offered by the modern engineering salesman is not always appreciated by the engineer, principally because of a misunderstanding of the motives back of the service. The training of a salesman of lubricating oil may be taken as a measure of his value to the engineer. He may be an experienced practical engineer who has worked his way up from the scoop shovel to the chief's job, or a graduate mechanical engineer with several years' experience in the plant who has entered the selling field. It is well to keep in mind that although he has become a salesman, he is still an engineer.

Before he can represent a company the new salesman must receive specialized training so that he can advise authoritatively. This training takes a year of hard work learning how the crude oil is obtained, what crudes can be used, how they must be treated and the applications of the finished product. In other words, he has specialized in the application of his line to the engineers' needs, but this does not state nearly his value, because back of him is an organization contributing its findings from the laboratory and experiences in the field to reduce the cost of operation. This organization is spending large sums of money to improve the service, because only by improvement can the company meet competition and stay in business.

The salesman is the connection between the supply and the consumer. He brings the concentrated extract of information on the subject, and his instructions are to serve the buyer by aiding him in the wise choice of goods that will best fill the requirements. The day of the slicker type salesman is over and a new man has been calling for some time. He is not selling oil, but lubrication, and to sell it for mutual advantage he must keep the cost down to a minimum or someone else will do it and secure the business.

The writer has been taking the advice of salesmen for some time and the result has proved enlightening. Handing over the supervision of various details of the plant to the same number of expert salesmen has given me more time for management. As an example, the cost of lubrication is one-half of what it was before the salesman took charge of that detail. Besides this reduction in the cost of lubrication, the writer has learned something about oil and acquired a new interest in this part of his work.

In the same way the cost of packing was reduced 30 per cent and furnace repairs cut 15 per cent, because the care of the furnaces was turned over to a company whose business was refractories. Thus from one end of the plant to the other there are experts at work and all the writer has to do is to control the assembly. You may be sure that the salesman receives a hearty welcome in my plant. L. A. COWLES.

Vermillion, S. Dak.

Remetaling Babbitt Bearings

I have read with interest the article on "Remetaling Babbitt Bearings" by E. Andrews in the Jan. 19 issue, and should like to add a few remarks to what has already been said on this subject. In general it may be said that the essential characteristic of a desirable bearing alloy is to have hard grains imbedded in a relatively soft material. Satisfactory results are generally obtained with babbitt metals containing tin-antimony-copper, tin-lead-copper and tin-antimony-lead mixture, but the copper-tin, tin-antimony and lead-antimony mixtures are less efficient. Lead base metals lack the tough body so essential to absorb shock. Experience shows that babbitt metals should be selected according to the speeds and pressures, the size of the bearing and the thickness of the babbitt lining. It is not necessary that a different babbitt metal be used for each slight variation; but a different grade is preferable where the conditions are radically different. Practically three grades will cover all mechanical conditions—one for general light work, one for medium-speed heavy-duty work, with now and then an exception—that is, an extremely heavy load with low speed, a high speed with a comparatively light load or a small, thin-shelled bearing built out of all proportion to the load and to the speed. Although one or two grades might generally give satisfaction, economy would be best served by selecting a grade most suited to one of these three or to the special conditions.

It is well known that the prevailing high price of tin has led to the substitution of other metals that are marketed under the name of "babbitt metal." These cheaper grades, when properly made, are for some purposes equally as serviceable as genuine babbitt. The problem in the power plant is to determine what needs are the most exacting or when a breakdown would cause the greatest damage, and confine the use of high-tin babbitts to these uses only.

It is thought by some engineers who make their own babbitt metals that the quality is influenced by the order in which the different metals are melted and combined. This, however, has been disproved by experiments, the results of which indicate that, as regards bearing metals, foundry secrets of mixing have only a fancied value, and that although some particular methods may have value as to convenience or even as to accuracy of the final product, they are not essential as regards the quality of the bearing metal.

In modern practice, in order to insure the proper alloy or uniformity of composition in babbitt metals, a furnace is provided with a mechanical device for thoroughly mixing the components of the babbitt. This device takes the form of a propeller, which is rotated in the melting pot by means of a handle. The molten babbitt is drawn off from the melting pot through an outlet at the bottom. A thermostatic regulator, which acts on

the fuel supply and can be set to suit any particular grade of babbitt, maintains the metal at the proper temperature. An oven for heating the shells of the bearings before they are tinned is fitted with a similar automatic controller, which keeps the temperature at the correct point for tinning, and the shells need simply to be rubbed with a stick of tin as they are withdrawn.

Experience shows that all bearings that are to have babbitt linings should be well tinned beforehand. The parts not to be tinned should be coated with a thin mixture of graphite and water. When the bearing is dry, apply the following flux to the parts to be tinned: Anhydrous zinc chloride, 50 per cent; ammonium chloride, 49 per cent, and sodium fluoride, 1 per cent. Then immerse the bearing in a bath of molten solder consisting of 66 per cent tin and 34 per cent lead. As stated in the article referred to, the bearing should be babbitted immediately after it has been tinned. Putty is preferable to clay for luting the bearing ends, as the moisture in clay tends to cause sputtering and may injure the workmen. If the bearing to be babbitted is large, requiring considerable metal, a large melting pot should be used. It is essential to have plenty of metal melted to insure babbitting the bearing in one pour. The melting of the metal should be done as near to the work as possible in order to prevent chilling of the babbitt by carrying it a long distance. The metal is ready to pour when a light pine stick held in the molten metal chars and transmits a vibration or trembling feeling to the hand. Avoid overheating or burning, otherwise a percentage of the alloy is lost when this occurs. Moreover, babbitt metal poured into a bearing at a temperature far above its proper melting point is generally coarse grained and makes a poor lining. Rapid cooling produces a fine, even grain.

In conclusion it may be stated that the important points in the production of babbitt bearings are briefly: Clean melting pot and ladles; clean bearings; properly tinned surfaces; proper preheating of mandrels and bearings; provision of suitable vents; maintaining the babbitt at the proper temperature; stirring thoroughly when mixing the metals; pouring at the correct temperature; properly shaped ladles; cooling the bearings.

London, England. E. DARWELL.

Engineering and the Man

The following surprising statement appears in an article entitled "Engineering and the Man," by E. Ogur, in the Jan. 5, 1926, issue:

"The closing of 80 per cent of our technical schools would in my opinion be a veritable act of benevolence. Twenty per cent of the present output of technical schools is all the industry can absorb, all it does absorb. The rest have to turn to other vocations after wasting eight to ten of the best years of their lives."

The first sentence is an opinion apparently based on a loose statement in the second sentence, and the third sentence, if true, would raise the question of what constitutes a waste in engineering education. Let us briefly review a few facts and figures.

The recent report of the Committee on Engineering Students and Graduates* shows that but 10.2 to 22.2 per cent of the recent graduates are in non-engineering work. The 22.2 per cent is for chemical engineering, and for the civil, electrical, mechanical and mining courses the highest figure is 16.1 per cent. In the case of mechanicals, the report shows that, proportionally, the number of older graduates remaining in the same or closely related lines of work as their course in college is about the same as the number of recent graduates so remaining. In other words, industry holds as large a proportion of the older graduates as it absorbs and uses of the younger men.

The evidence at hand seems to indicate that industry is absorbing the present output of engineering graduates. In this connection I may refer to the placement of graduates in mechanical engineering at the Pennsylvania State College. The call for these men during the past four years has exceeded the supply three to four times over; industry has absorbed 100 per cent and would have taken at least twice as many if they were available. Furthermore, the number of inquiries for our mechanical graduates with two to five years' experience has been unequaled in years. But few of these men could be drawn away from their present positions (and salaries) in order to fill these openings. Mr. Ogur's statements as quoted are not substantiated by our experience at Penn State, and I question if he can find evidence to support his claim in other institutions. On the other hand, I agree fully with him that the country needs a larger number of high-grade professional engineers.

Suppose, for the moment, that industry can absorb but 20 per cent of the output of the technical schools. This would imply simply that industry would have to follow the college in the selecting and weeding out process. If 80 per cent of the engineering schools were closed because but 20 per cent of their product was absorbed, industry would be at a disadvantage, for there would be little opportunity of discriminating selection, as is now the case. Many writers seem to forget that our technical schools are, first of all, training for successful and better living. If one does not continue in engineering, who will say that one's time is wasted? Fortunately, the above conditions do not now exist; we do not have to "suppose." Our job is to meet the present demand for trained men. All too few of the young men of college caliber know of the opportunities in mechanical engineering, and we need a larger number of the best high-school boys who are qualified and who desire to enter this field.

Possibly the engineering schools fail to measure up to our expectations, but is not this true, in the large, of all endeavors to assist mankind? In his article Mr. Ogur implies that the college tends to kill enthusiasm, determination and ambition. Personal qualities such as these will not take one far in life's keen competition if not tempered with culture, ability to reason and capacity to execute. A young man who has been educated out of persistence and "pep" does not seem to be a common product of our engineering schools.

If Mr. Ogur had a more intimate contact with the teaching side of engineering, he would be more guarded in his criticisms. The purpose of an engineering education is to teach men to think straight and to ground them in the fundamentals.

Fortunately, industry and engineering education are working together as never before, and the result of this closer relation is proving to be of advantage of both interests. May it continue. A. J. WOOD,

Professor of Mechanical Engineering.

State College, Pa.

Journal of Engineering Education, December, 1925; *Mechanical Engineering*, December, 1925.

A new slant on things observed in and out of the power plant

What Happens and Why?

Does Pressure Increase Bolt Tension?

WHEN a head is attached to a cylinder containing a fluid under pressure, as for example a steam-engine cylinder, the studs or bolts must be screwed down tight enough at the start to prevent the fluid leaking out past the gasket and also to prevent the gasket being blown out bodily by the pressure. The question has been frequently raised, "What effect does this initial tension in the studs or bolts have upon the final tension after the fluid has been brought up to pressure within the cylinder?" The offhand judgment of most engineers who have not thought much about the matter would be that the pull due to the pressure in the cylinder would merely be added directly to the initial tension of the studs or bolts.

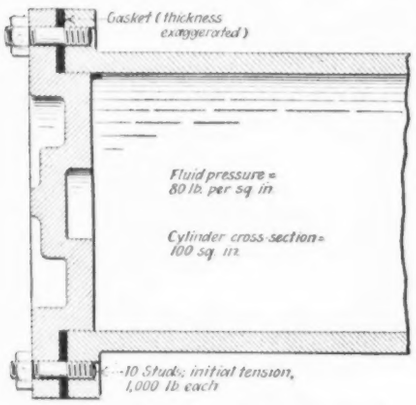

Gasket (thickness exaggerated)
Fluid pressure = 80 lb. per sq. in.
Cylinder cross-section = 100 sq. in.
10 Studs; initial tension, 1,000 lb. each

Fig. 1—What is the final tension?

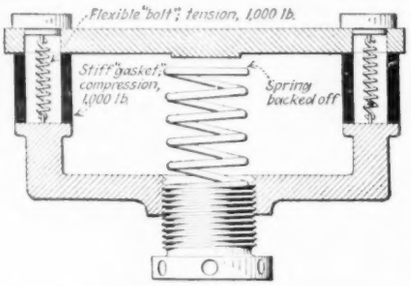
According to this theory, if the studs of the cylinder head shown in Fig. 1 had an initial tension of 1,000 lb. each, due to tightening up of the nuts, the tension in each would jump to 1,800 lb. when the steam pressure rose to 80 lb. per square inch. This would be figured on the basis that 80 lb. per square inch applied over a cross-sectional area of 100 square inches gives 8,000 lb. total push on the cylinder head, which, divided by 10 bolts, gives 800 lb. on each. No one can dispute the fact that 800 lb. added to 1,000 gives 1,800 lb.

The trouble with this line of reasoning is that the 800 lb. does not necessarily add itself to the 1,000 lb. It may or it may not. What actually happens depends largely on the relative elasticity of the gasket and the studs.

The model shown in Figs. 2 and 3 covers in an exaggerated way the case where the bolt is far more "springy" than the gasket. Here the bolts are represented by slender springs in tension, whereas the gasket is represented by stiff collars of steel having practically no "spring" at all in comparison with the "bolts" they surround.

The effect of the steam pressure is produced by a heavy adjustable compression spring in the center. With this backed off, corresponding to a condition of zero steam pressure, the "bolts" are tightened up to 1,000 lb. each, producing a compression of 1,000 lb. on each "gasket."

Then the central spring is screwed up against the plate with a total force of 8,000 lb., or 800 lb. for each of the ten "bolts." This falls short of the amount necessary to lift the cylinder head clear of the "gaskets." Hence the length of each "bolt" will not be changed appreciably. It is self-evident that if the length of a spring does not change, its tension cannot change. Therefore the addition of "steam pressure" amounting to 800 lb. for each bolt has no effect on the tension in the bolt, merely reducing by 200 lb. the force with which the head bears against each "gasket."

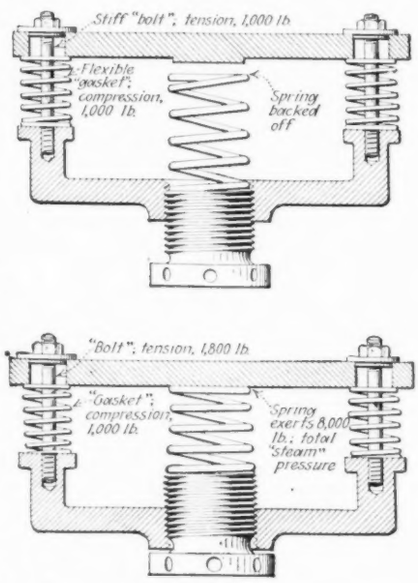

"Flexible "bolt"; tension, 1,000 lb.
Stiff "gasket"; compression, 1,000 lb.
Spring backed off
"Bolt" tension, 1,000 lb. as before
"Gasket" compression reduced to 200 lb.
Spring exerts 8,000 lb. total "steam" pressure"

Figs. 2 and 3—With flexible bolts and stiff gaskets steam pressure does not affect bolt tension

Now let us take the other extreme. Suppose that the gasket is so flexible, due to its material or thickness, that the bolt may be considered by comparison as absolutely rigid. This condition is illustrated by the model shown in Figs. 4 and 5. Here it will be noted that the bolts or studs are represented by actual studs of steel, whereas the gasket is represented by coil springs in compression. As before, the effect of steam pressure is produced by a heavy adjustable spring in the center.

With this center spring backed out of the way, the "bolts" are tightened down to an initial tension of 1,000 lb. each, squeezing the "gaskets" considerably in the process and compressing them to 1,000 lb. each. The heavy center spring is screwed up against the plate with a total force of 8,000 lb., or 800 lb. for each of the ten "bolts." Although the "bolts" will stretch a minute amount, this will be altogether too small to have a practical effect on the compression of the "gaskets," which will continue to exert a force of 1,000 lb. each as at the start. It is obvious in this case that the tension in each bolt must rise to 1,800 lb., since it carries 1,000 lb. from the "gasket" and 800 lb. as its share of the "steam pressure."

By assuming two extreme cases, it has been proved that the limiting possibilities are: First, the pressure adds nothing whatever to the tension; Second, it adds its full share to the bolt tension. In an actual steam-engine cylinder or other pressure cylinder the ratio between the springiness of the bolt and that of the gasket must determine whether the existing condition is more like that represented in Figs. 2 and 3 or that in Figs. 4 and 5. Without figuring out all these elastic forces, all that can be said is that the tension must lie between the two limits indicated. In practical machine design, uncertainty on this point is usually eliminated by assuming that the bolts or studs carry the full fluid pressure in addition to the initial tension.


Stiff "bolt"; tension, 1,000 lb.
Flexible "gasket"; compression, 1,000 lb.
Spring backed off
"Bolt"; tension, 1,800 lb.
"Gasket"; compression, 1,000 lb.
Spring exerts 8,000 lb.; total "steam" pressure

Figs. 4 and 5—Steam pressure increases tension where bolts are stiff and gasket springy

Safety Suggestions for Pulverized Coal

An investigation of explosion hazards from the use of pulverized coal as a fuel at industrial plants has been made by the U. S. Bureau of Mines.

The principal constituents of coal that have a direct bearing on the explosibility of coal dust are moisture, volatile matter, fixed carbon and ash. Fineness is the physical characteristic that governs the explosibility of pulverized coal. Pulverized coal in bulk is not explosive. It becomes dangerous only when stirred up into a cloud with the proper proportion of air and brought in contact with an open flame or a body having a temperature high enough to ignite it. To reduce the explosion hazard, there should be absolute cleanliness and freedom from any accumulations of dust, both in the pulverizing plant and in the buildings in which the pulverized coal is used as fuel. Accumulations of dust on the floor or machinery should never be brushed or swept up without the dust being either wetted or thoroughly mixed with an excess mixture of fine incombustible material.

Ventilation and Light Important

All coal-pulverizing plants should be adequately ventilated and lighted, and when practicable some method of cleaning by a vacuum system should be installed. All open lights in and around coal-pulverizing plants should be prohibited, and employees should not be allowed to smoke while in the building. The drier and drier furnace should be separated by a fireproof partition from the pulverizing mills, conveying machinery and storage bins.

Where furnaces and boilers are equipped with individual fuel bins, these bins, if possible, should be isolated from the boilers or furnaces. All pulverized-coal bins should be tightly closed and never opened if there is any possibility of ignition from an open flame. Bins should be equipped with automatic indicators to indicate the amount of coal in the bin.

Only men of known reliability should be intrusted with the direct operation of a drier.

Special care should be taken not to overheat the coal in the drier, and recording pyrometers should be installed to enable the officials of the plant to check the operation of the drier. The operation of the drier should never be stopped while it contains a charge of coal. Fire in the drier furnace should never be started with paper, shavings or any light combustible material.

Because of the liability of spontaneous combustion, dried or pulverized coal at a temperature over 150 deg. F. should never be stored in a bin more than eighteen hours. Whenever a plant is to be shut down for a few days, all storage bins should, if possible, be emptied of coal.

Whenever pulverized coal becomes caked in bins, transport lines or conveyers, it should not be jarred off by hammering, because of the liability of causing leaking joints.

A coal-line compressed-air tank or storage bin should never be opened in the vicinity of a flame or open light.

All electric wires and cables should, as far as possible, be inclosed in conduits, preferably rigid iron conduits. All switches should be placed outside the pulverizing plant or in dustproof casings. Precaution should be taken against sparks from static electricity in all rapidly moving machinery by having it thoroughly grounded.

Dust should never be allowed to accumulate upon electric-light bulbs, and the bulbs of all portable lights should be protected by heavy wire guards. Care should be taken to prevent arcing from loose socket connections or imperfectly insulated cords.

Detailed safety instructions are given in Bulletin 242, "Explosion Hazards from the Use of Pulverized Coal at Industrial Plants," by L. D. Tracy, coal-mining engineer, copies of which may be obtained from the Bureau of Mines, Department of Commerce, Washington, D. C.

Relative Merits of Different Methods of Deep-Well Pumping*

ONE of the common methods of obtaining suitable water supply for railroad requirements is by means of drilled or artesian deep wells. Surface supplies or shallow well supplies are not always available, and in some cases a better quality of water from both sanitary and chemical standpoints can be secured from deep water-bearing strata. On account of the depth to reach these deep-well supplies and the limited space available for pump installation and operation, the surface types of pumps cannot be used and special deep-well pumping equipment must be installed. In general, the most common types of such pumping equipment are the deep-well reciprocating pump, the deep-well centrifugal or turbine pump and the air lift. The deep-well pumps consist primarily of three parts: the water end, preferably submerged or sufficiently close to water level to avoid loss of prime; the power end, above ground or at least readily accessible, and the transmission line or driving mechanism connecting the power end with the water end.

On the water end the deep-well reciprocating pump consists of the working barrel or cylinder, plunger and valves. The top of the working barrel is fitted with a coupling and attached to the lower end of the drop line or discharge line from the working barrel to the well head. The plungers are operated from the power end by working rods of wood or steel or a combination of the two. The power end or working head may consist either of a steam cylinder with the piston rod directly connected to the working rods and plungers or of a crankshaft or cams with connecting rods to the working rods and plungers, the latter type being driven by motor, steam engine or internal combustion engine directly connected through reducing gears or belt driven through reducing gears. The deep-well reciprocating pumps are made in the following types: single-plunger, single-acting; single-plunger, double-acting; double-plunger, single-acting, and triple-plunger, single-acting.

Of the deep-well centrifugal or turbine pump the water end consists of a horizontal turbine pump with a sufficient number of impellers or stages to deliver water against the required working head. The pump is coupled or flanged to the lower end of the drop line or discharge line to the well head. The impellers are operated from the power end by a steel shaft, which passes through a stuffing gland and into the discharge line and extends through the discharge line to the pump. Guides are placed at intervals in the discharge line to keep the shaft in proper alignment. The power end or driving head at the ground level supports the shafting to the pump and provides a housing for the thrust bearing and discharge elbow or tee. Driving power may be either a vertical electric motor directly connected through a flexible coupling to the shaft, or a motor, steam or internal combustion engine belted to the pulley on the pump drive shaft. Where the total head above the ground level is large, a type of deep-well turbine pump can be secured with a built-in "booster centrifugal pump" at the ground level connected to the vertical drive shaft.

The water end of the deep-well air lift pump consists of a nozzle or foot piece submerged sufficiently deep so that the distance from the water level in the well when pumping to the foot piece is from 30 to 60 per cent of the total distance from the foot piece to the point of delivery of the water. Compressed air is forced down a smaller vertical pipe inside the well casing and issues from the submerged nozzle or foot piece. Air bubbles are formed in the entire column of water in the well, which lower the specific gravity of the water column and cause it to rise assisted by the upward impulse of bubbles. At the point of delivery the air separates from the water and is freed. There are no working or moving parts in the well. The power end of the air-lift pump consists of an air compressor of suitable capacity and type for the services demanded. The compressor may be driven by motor, steam or internal combustion engine.

In considering the relative merits of the different methods of deep-well pumping, consideration should be given to the following features: character of the water; capacity of source of water supply; pumpage required; pumping head; first cost of complete installation of equipment; length of useful life; reliability; flexibility; efficiency, and cost of operation.

At locations where the water to be pumped from the deep well contains an appreciable amount of sand or gritty material, the air-lift pump will give the best and the reciprocating pump the poorest service. The air lift, having

*From report of committee on water service of the American Railway Engineering Association, at annual convention of American Railway Engineering Association, Chicago, March 9, 1926.

no working parts, is not affected to any large extent by such materials in the water. The leathers and valves in reciprocating pumps quickly require renewal under such conditions. The impellers and bearings of turbine pumps are worn by the gritty material and replacements or repairs are needed at intervals. The aërating effect obtained through use of the air-lift pump aids in the removal of iron and other impurities in the natural water. Back-blowing of wells with air to increase the flow and shut off the sand is also accomplished readily with an air-lift installation.

Where the yield of a well is relatively small and the stratum is moderately deep, the reciprocating pump is most desirable. The turbine pumps are primarily large-capacity pumps and are not suitable for low yields. If a single well will not furnish the pumpage required, and if wells are widely separated, the air lift is conveniently used at each well by piping compressed air from a central compressor station. For a given diameter of well, the air lift will produce the largest yield.

Turbine Pumps for Large Volumes at Moderate Heads

If the water stratum is capable of delivering large volumes of water and the depth does not exceed 150 to 200 ft., the turbine pump will produce most economically the largest volume of water. The reciprocating pump will give satisfactory service at depths up to 300 to 400 ft., although at these depths the weight of rods requires large power heads and the delivery is limited to relatively small amounts. The air is limited as to depth only by the limitations of the compressor; by installing stage lifts or auxiliary starting jets, the same compressor can be used for considerably greater depths. On account of the submergence necessary the air lift requires a well hole of greater depth than the water-bearing formation, provided the yield is low. With no working parts, the air lift can be installed in wells that are considerably out of plumb and in which reciprocating or turbine pumps would not give satisfactory service.

Reciprocating pumps are made to fit in well casings from 5 up to 30 in. diameter and are capable of yields from 20 to 2,500 gal. per minute. The turbine type pumps are made to fit in well casings from 6 up to 24 in. diameter with yields ranging from 100 to 5,000 gal. per minute. The air-lift pumps are made to fit in well casings from 3 to 18 in. diameter with yields from 15 to 3,300 gal. per minute.

In general, the first cost of the turbine-type pump is highest and the first cost of the air-lift pump, including compressor but not prime mover, is lowest. The direct-connected motor-driven turbine pump, however, requires less housing than either of the other two types.

As to reliability and length of useful life, the type and fitness of the pump for the service required are large determining factors. With no working parts below the ground, the air-lift pump is probably the most reliable, although the compressor unit may give occasional trouble. The centrifugal or turbine-type pump has fewer working parts to get out of order than the reciprocating pump. The high speed of the turbine-pump shafting, however, demands careful alignment of the shaft and attention to the bearings. To insure reliability the pump must be of the proper type to fit the conditions, of ample capacity, well designed and of stout construction.

All three types of pump are flexible to a certain extent. The reciprocating pump is the most flexible over a medium range of pumping yields with the least variation in pumping efficiency. The turbine type is most suitable for constant conditions of head and yields. The air-lift pump is flexible over a great range of heads and yields, although the efficiency is altered considerably. It can be adjusted most easily for increasing or decreasing the setting. The turbine type pump can be used to deliver direct into supply mains and is not injured by sudden closing of the discharge. The air-lift pump cannot be used successfully for discharging into closed piping systems, but by the application of a booster tank the discharge can be raised to a reasonable elevation, the air separated from the water, and gravity flow used to the mains.

For protection against fire, the turbine-type pump is most desirable, as it furnishes a large quantity of water without pulsations. The air-lift pump alone cannot be used successfully for fire protection.

Higher Efficiency of Reciprocating Pump

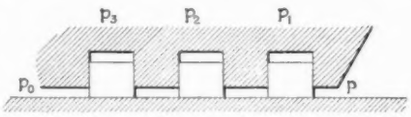
Being of positive action, the reciprocating pump will yield a higher efficiency than a turbine or an air-lift pump. Losses occur in turbine pumps on account of the high-speed "churning" action upon the water, whereas thermodynamic losses from compressed air cut down the efficiency of the air-lift systems. In general, efficiencies of the reciprocating pumps will reach 80 per cent under favorable conditions, turbine pumps 65 per cent, and air-lift pumps 35 per cent. On account of its low efficiency the air-lift pump is seldom used except under specific conditions that would make the other types of pump unsuitable.

Under average conditions maintenance costs of the air-lift systems will be lowest and of reciprocating systems highest. Attendance costs are relatively the same. Each of the three systems can be operated automatically, if desired. As the pumping economy depends largely on a suitable pump and power equipment for given conditions, after a choice of pump and equipment has been made and the pump installed, tests should be run at convenient intervals to develop what changes, if any, have occurred in operating conditions. A record of all inclusive costs of pumping should be kept for ready reference and comparison.

Each type of deep-well pumping equipment has its respective advantages and disadvantages over other types. To insure reliability and greatest overall economy, individual conditions should be thoroughly considered and analyzed before choice of equipment is made.

Measuring Piston Ring Friction

The following abstract from *Zeitschrift des Vereines Deutscher Ingenieure* of Feb. 27 is from a report on "Piston Ring Friction," by T. E. Stanton as submitted to the Aeronautic Research Committee (German). The



lb. per sq.in.

p	p_1	p_2	p_3	p_0
19.9	17.9	16.9	1.9	0
79.6	78.2	76.7	17.9	0

Fig. 1—Pressures within piston ring recesses

results confirmed previous findings of similar tests, which show that the piston ring friction increases inappreciably with the gas pressure behind the piston. Measurements of the pressure within the piston ring recesses were also taken and found to be surprisingly high, as tabulated in Feb. 1.

To the uninitiated it may appear that the high air pressure against the inner side of the piston rings would cause a considerable increase in their friction, but the tests have shown that when the total pressure (air pressure plus spring action) is increased to five

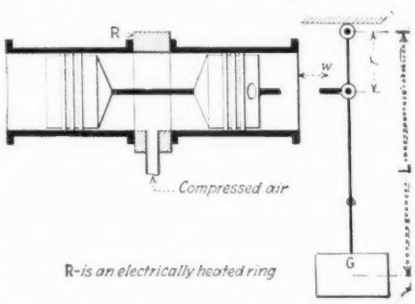


Fig. 2—Test apparatus for measuring piston ring friction

times the normal value, the corresponding friction increases only 1.6 times. It is even likely that this figure is too high, due to other causes that may influence the readings.

Fig. 2 illustrates the test apparatus. By setting pendulum G in motion and noting the retardation of its travel, the ring friction W may be calculated. The swing of the pendulum decreases by $4rW \div LG$ with each complete oscillation.

R is an electrically heated ring which will raise the temperature of the compressed air between the pistons up to 100 deg. C. The cylinders are 90 in. in diameter, corresponding with those of an air-cooled Renault engine.

An Easy Way to detect an overheated bearing is to paint a spot with the special paint which is black when cold and which turns a bright red when hot.

New and Improved Equipment

Grindle Multi-Stage Vertical Unit Pulverizer

A vertical mill of the impact type containing a series of hammers swinging radially in five horizontal stages increasing in diameter from the top down has been brought out by the Grindle Fuel Equipment Co., a subsidiary of the Whiting Corporation, of Harvey, Ill. A vertical motor mounted on top of the pulverizer and directly connected turns the rotor of the machine at 1,800 r.p.m. An independent feeding mechanism is belt driven from

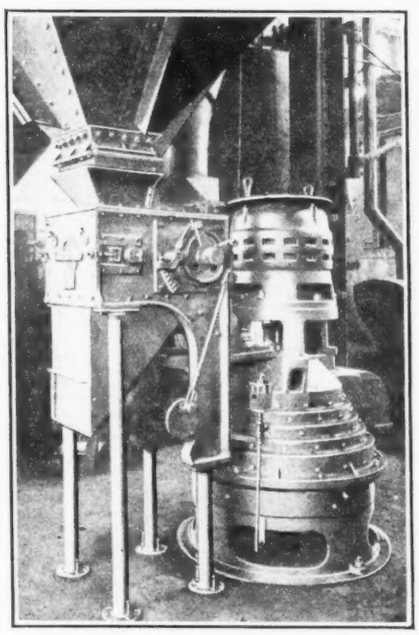


Fig. 1 — Multi-stage pulverizer and feeder in boiler plant of Whiting Corporation

the motor shaft with a worm gear reducer and ratchet to give the desired rate of travel to the feeder belt. Coal with a moisture content up to 12 per cent is handled successfully by this mill without drying. Reducing it to a fineness so that 75 per cent passes through a 200-mesh screen requires approximately 12 kw.-hr. per ton of coal containing 3 per cent moisture or less. The mill is made in one size, having a capacity range from 500 to 5,000 lb. per hour. A larger mill with an output of 4,000 to 10,000 lb. per hour is in the development stage.

Reference to the accompanying illustrations will show the design. Fig. 1 is a photograph of one of the improved multi-stage mills installed in the power plant of the manufacturer. This shows the feeding mechanism at the left and the vertical mill and motor at the right. Fig. 2 shows the mill proper with the top housing raised, and Fig. 3 is a sectional drawing showing the interior construction. The illustrations last named show the five stages and in each the swinging hammers or beaters, which are pivoted between steel plate disks and are free to swing 90 deg. to either side. These beaters are reinforced at the point of greatest wear and are reversible, so that when one side is worn down, the beater may be turned over to present a fresh wearing surface. They may be renewed through the handhole in the top housing.

Opposite the beaters in each stage are corrugated rings bolted to the housing. As the coal drops onto the top disk of the pulverizer, it is thrown out by centrifugal force against the corrugated pulverizing ring. On the rebound the beaters strike it, pulverizing the coal finely enough to drop down to the next stage, where the same process is repeated, until the coal finally passes into the discharge passage below. Gravity and the suction of the fan blades at the bottom of the rotor draw the coal through the circumferential spaces from one stage to the other as soon as it has been pulverized to the proper fineness. In the discharge

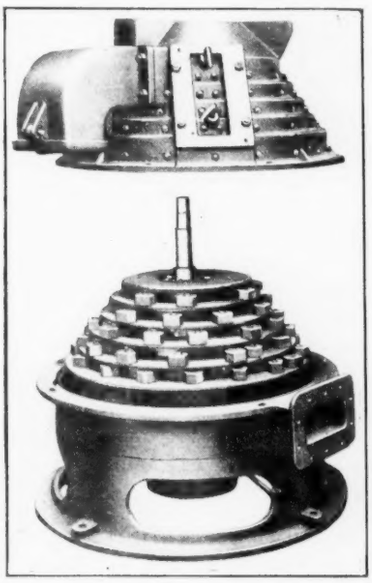


Fig. 2—View of pulverizer with top housing raised

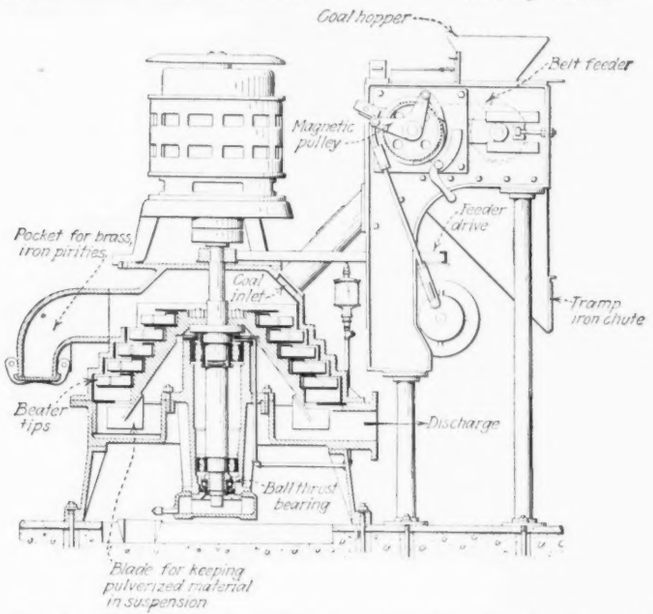


Fig. 3—Complete unit showing construction of pulverizer and feeder and the bearing arrangement

casing the pulverized coal is kept in agitation by the fan blades and is blown directly to the furnace if the intervening distance to the boiler is short. The fan is designed to furnish a low volume of air at relatively high pressure for this purpose. For large installations or where the distance between the mill and the furnace is comparatively great, an independent booster fan is used.

Air is admitted to the mill through a sliding gate in the feeder and through a number of holes in the inner vertical wall of the discharge chamber, which are fitted with pipe plugs that may be removed as required. About 20 per cent of the air required for combustion is supplied in this way, or just enough to carry the coal to the furnace. The remainder of the air is admitted through openings around the burners and through openings in the furnace lining through which preheated secondary air from ventilated furnace walls is drawn by natural draft.

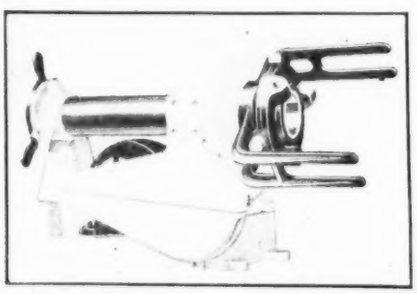
To supply the mill, coal of 1½ in. size or under is fed from an overhead bunker onto the belt feeder. As indicated, the belt is of the endless type with an adjustable pulley at one end and a magnetic pulley at the other. The coal passes over this magnetic pulley and drops into a chute leading to the mill, and the tramp iron is carried past this feed chute and is automatically deposited in an inclined pocket at the rear of the feeder. The belt travels slowly and the rate of feed may be varied by adjusting the stroke of the ratchet pawl.

As the coal drops onto the top disk or stage of the pulverizer any foreign material such as brass, wood, slate, iron pyrites, etc., which passes by the magnetic pulley is thrown out by centrifugal force and deposited in the foreign material box indicated in Fig. 3. The high speed at which the disk is revolving throws the coal out against the corrugated rings of the beehive housing, and when it is pulverized to the proper fineness by the heaters, the coal is drawn through the mill and discharged to the furnace.

Oster Power Drive for Pipe Tools

The Oster Manufacturing Co., of Cleveland, Ohio, has recently introduced a lighter weight model of its power drive for pipe tools.

The body of the machine, which was formerly made of cast iron, is now made



Light-weight power drive for pipe tools

almost entirely of an aluminum alloy. This has reduced the weight to 150 lb. and made the machine readily portable as a unit, without removing any parts.

The driving power is furnished by a ½-hp. universal reversible motor, which automatically speeds up on the smaller sizes of pipes and holds the necessary speed on the larger sizes, giving the outfit a greater production capacity. Its reversible feature makes it possible to use nearly any die stock.

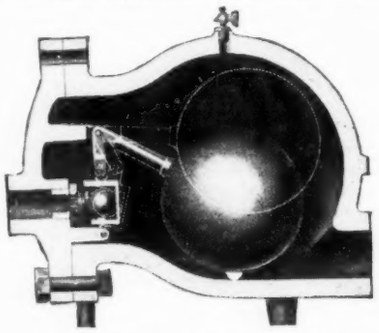
The machine is designed to drive die stocks and pipe cutters up to 2-in. capacity, but with a special auxiliary drive shaft which can also be furnished, geared die stocks and cutters up to 6-in. capacity can be driven. In addition to this, the machine can be used to screw up fittings, as a pipe wrench can be held in the driving arms and revolved.

The pipe is held stationary in a three-jawed, self-centering chuck and the pipe tools are turned by the driving arms. Self-centering universal guides in the rear of the machine assist the front chuck in centering long lengths of pipe.

Williams Ball Seat Trap

The employment of a ball valve is a feature of the trap brought out recently by the Williams Gauge Co., Pittsburgh, Pa.

Referring to the illustration, which shows a cross-sectional view of the trap, the ball is held in a cage, which is in turn operated by a float. The



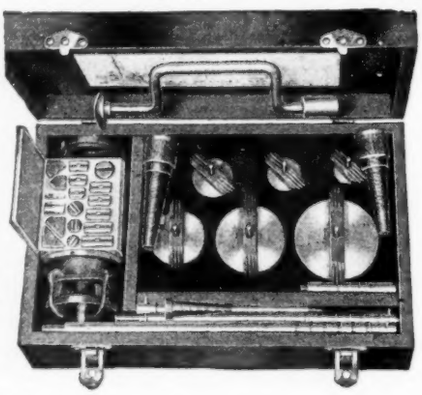
Cross-sectional view of trap

connections between the float and the cage and the cage itself are designed to produce practically instantaneous opening and closing so that wire drawing is reduced to a minimum. The open position of the float and cage is shown by the dotted lines in the illustration.

The float is made of chrome nickel tested at 600 to 1,200 lb. and the ball and seat are of Monel metal. As will be seen from the illustration, the working parts of the trap are readily accessible, these being carried from the bolted flange on the front of the trap.

Skinner Combined Reseating Tool

The W. B. Skinner Co., Chicago, Ill., has recently combined its line of reseating tools into one complete set, suitable for reseating valves from ¼ to 3 in. The tool is equipped with screw feed

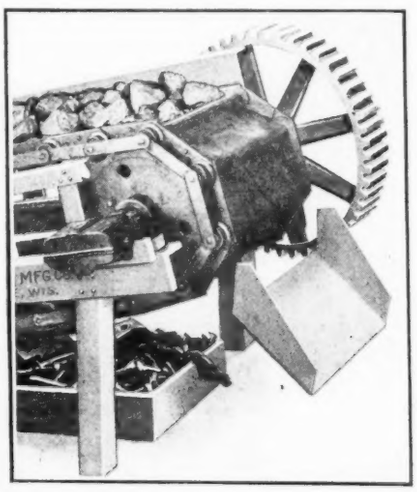


Reseating tool for valves up to 3 inches

for all sizes, and the operating spindles carry six adjustments for high and low valves. The tool lines up through a taper sleeve screwed into the bonnet of the valve. There is also a guide below the cutter consisting of a disk with a number of ball bearings set in the outer edge. These ball bearings, backed up by springs, project a few thousandths of an inch beyond the circumference of the guide and take up any "play." Cutters in the flat and 45 deg. angle, numbering 24 in. all, are included in the set, which is packed in a hardwood case and weighs approximately 14 lb.

Magnetic Apron Conveyors and Feeders

A new type of magnetic pulley adapted to operate in the discharge end of apron conveyors and feeders is announced by the Magnetic Manufacturing Co., of Milwaukee, Wis. It has been necessary heretofore, where apron conveyors and feeders were employed, first to discharge the material onto a belt conveyor provided with a magnetic head pulley for extracting the tramp iron. The new development under discussion makes it possible to include a high-powered magnet at the discharge end of the conveyor or feeder and thus eliminate the necessity for any auxiliary apparatus. The magnet is specially designed to conform to the shape and style of the pan used. Experience in several active installations has shown that it is necessary to bring the poles of the magnet into close contact with the under side of the steel apron and use extra large coil windings to



Magnetic separator applied to apron conveyor

build up a strong magnetic flux. The heavy loads carried on a conveyor of this type make a high-powered magnet desirable, as the magnetic lines of force must pass through the steel apron plates and to a considerable depth into the material. The operation is practically the same as in a belt conveyor unit.

The magnet is mounted on a shaft between the regular drive sprockets, the shaft having a drive extension on either end. Where an existing conveyor is to be equipped with magnetic equipment, it is recommended that the unit be provided with a new shaft and sprocket, so that a quick change can be made when mounting into position.

One of the outstanding features in this equipment is that no additional power to drive the apparatus is needed outside of the direct current required for the magnet. Where no direct current is available, a generator or a motor-generator set can be supplied.

News in the Field of Power

Quebec Now Has Law Against Power Export

The province of Quebec has taken definite action in the matter of exportation of electric power to the United States. The bill prohibiting the exportation of power was adopted in the Legislature on March 22. It provides that every sale, lease or grant of water powers belonging to the province, or in which it has rights of ownership, must contain a clause prohibiting the exportation, outside of Canada, of any electric power which may be developed in the province.

New 1,000,000-Kw. Station at Indiana-Illinois State Line

Further details of the new million-kilowatt State Line station on the shore of Lake Michigan, as mentioned in the Feb. 23 issue have just been announced. It will be owned and operated by the State Line Generating Co. which will be exclusively a "manufacturer" and wholesaler of electrical energy for the following Insull properties: The Commonwealth Edison Co., Public Service Co. of Northern Illinois, Northern Indiana Public Service Co., and the Interstate Public Service Company.

Construction will begin immediately. An eighty-acre site on the shore of Lake Michigan, assuring the water supply that is so essential to a modern electric station, is practically ready for the builders. The first unit, which will have the enormous capacity of 200,000 kw., will represent about 15 per cent of the estimated combined maximum demand in 1929 of the companies which will take energy from it. The initial expenditure will be about $25,000,000.

Four additional units of not less than 200,000 kw. each are contemplated—these to be installed from time to time as required—for an ultimate capacity of at least 1,000,000 kw. This will mean a single station with generating capacity practically equal to the combined generating capacity in the Chicago-Illinois-Indiana industrial area at this time.

Development of the State Line station is expected to be accompanied by development in underground transmission at high voltages far beyond anything yet attempted in this country. The Commonwealth Edison Co. of Chicago has already ordered six miles of 132,000-volt cable for a connection with the 132,000-volt overhead transmission system of the Public Service Co. of Northern Illinois. While this step is not directly connected with the State Line station enterprise, it is collaterally related to it. Up to this time underground transmission has been limited practically to 33,000 volts, although there is one piece of 66,000-volt underground cable in Cleveland and another ordered for Philadelphia.

Mellon Opposes Contemplated Financing of Colorado River Project

Bond Issue Not Help to Financing—Federal Control with Private Construction and Operation Suggested

EFFORTS to bring out the Swing-Johnson bill have met another setback. The Secretary of the Treasury has entered vigorous opposition to any plan of financing the project by the sale of United States bonds.

The Senate committee had tentatively agreed to report out the bill so as to give Senator Ashurst, of Arizona, an opportunity to make a point of order against the measure on the ground that it is a revenue bill and should originate in the House. The committee was anxious to have the vote from the Senate proper on that point. In view of Secretary Mellon's letter, however, the Senate committee probably will not act at this time. There is practically no prospect of securing favorable action on the part of the House committee.

Secretary Mellon in his letter took occasion to point out some of the weaknesses of public ownership in addition to condemning the proposed financial plan. Secretary Mellon's letter which is addressed to Chairman Smith of the House Irrigation Committee, follows in full:

I have your letter of March 6 requesting my advice on the financial plan proposed by H. R. 9826. This bill contemplates the sale by the United States of $125,000,000 of 15-50 year four per cent bonds and the use of the proceeds to pay for the cost of construction of a dam on the Colorado River and an irrigation canal to the Imperial and Coachella Valleys. I am not familiar with the engineering features involved, nor with the earning prospects of the project, and I accordingly express no opinion thereon.

Proceeds from the sale of our own bonds are not governmental revenues. The payment for the project by the sale of bonds has exactly the same effect on our governmental accounts as the payment of the same expenditure out of any governmental revenue, and the fact that it is a dam and might have earnings in the future does not differentiate it from an expenditure for a battleship, a public building, or pay of employees. In each case the expenditure would appear as an expenditure in the Treasury Statement, and if the sum of this expenditure and all other expenditures during the fiscal year was less than the revenue for that year from all sources, there would be a surplus. If this sum was in excess of the revenues there would be a deficit.

With our large government indebtedness outstanding, the effect of a surplus is to require less borrowing at the next quarterly refunding period, and the effect of a deficit is to require more borrowing. In other words, if there were no provision at all in the bill for the floating of the loan and the general revenues of the Treasury were insufficient to pay for the project, the Treasury would be obliged to obtain the cash to cover the costs of government operation in excess of government revenue.

The proposal for the bond issue, therefore, simplifies in no way the fiscal problem involved. As a matter of fact, the limitation in the bill as to rate of interest and maturity, and the power of the Secretary of the Interior to control some of the terms of the proposed issue would hamper the Treasury in meeting a money market which might exist at the time the securities had to be sold and to some extent would increase the cost of money to the government.

If the project is adopted by Congress, it would be, in my opinion, better fiscal policy to authorize the Secretary of the Treasury to pay for the project out of the general fund, or out of the proceeds of bonds authorized generally to be sold to replenish the general fund, and then earmark the earnings from the project to the payment of interest and principal on an amount of public debt equivalent to that created for this purpose. This policy would permit the Treasury to take care of our debt structure as a whole and in the manner most effective at the time.

If we eliminate the question of paying for the project out of the bond issue, which, as I have said, is no aid from a Treasury standpoint, then the question for the determination of Congress is, should the United States spend $125,000,000 in the construction of a power and irrigation project? I believe that, in general, sound public policy in America, as elsewhere, is to encourage private initiative and not to have government ownership or operation of projects which can be handled by private capital under proper governmental regulations.

The government operation of railroads in this country was our largest experiment on this line and a comparison of public and private operation in that field justifies my faith in private enterprise. Canadian and European experience is the same. To get the government out of business, whether it be in banks, utilities, or monopolies, has become one of the most essential steps to a permanent fiscal restoration of Europe, and I am loathe to have the United States embark upon enterprises not strictly governmental in their nature.

The fact that a government can furnish capital at lower rates of interests is illusory. If there be taken into account that the public project pays no tax and, therefore, does not bear its share of the cost of government. It seems to me that if the project is one which can pay its way, private capital can be found. If it cannot pay its way, then we should consider whether all the taxpayers throughout the United States should be taxed for the benefit of a part of the country.

To these general principles, which I feel to be correct, there may arise exceptions. The Colorado River project involves the adjustment of the interests of seven states and a division of water between the United States and Mexico. In a project which involves a compact between different states and an international agreement, it is apparent that action must be had by the federal government if a satisfactory solution is to be obtained.

It might be practicable to solve the problem through the federal government and still have the project constructed and operated by private enterprise. Congress may, however, feel that full or partial federal government ownership would be more convenient and under the particular circumstances the present case be made an exception to the general rule of sound policy.

If my suggestion as to a more satisfactory way of financing the project meets the approval of the committee, I shall be glad to have prepared a draft of legislation along this line.

The period of amortization of the cost of the project over fifty years seems to me a little long.

The total annual production of electric energy in Sweden increased from 2,986,000,000 kw.-hrs. in 1923 to 3,481,000,000 kw.-hrs. in 1924. In 1913 only 1,449,000,000 kw.-hrs. were generated.

Electrotechnical Commission To Be Well Attended

The ten-day convention of the International Electrotechnical Commission will be held in the Engineering Societies Building, 29 West 39th St., New York City, beginning April 13.

This will be the first meeting to be held in the United States of the Commission which functions through national committees representing the technical societies and governments of a score of nations.

Delegates will be sent by every country represented on the Commission, according to an announcement made by the president of the United States National Committee, Clayton H. Sharp.

The Commission is an international standardization body in the electrical industry, Mr. Sharp explained, and was organized in 1906 with Lord Kelvin as president, following suggestions made at the Electrical Congress held in St. Louis in 1904.

In 1924 the World Power Conference referred to the Commission the task of formulating an international agreement for the measurement of water power and the standardization of water power data. Development of these studies will be the chief theme of the New York meeting, it was stated.

The following countries will be represented by the delegates whose names are listed:

Belgium—Frans Dupont, chief engineer, Ateliers de Construction Electrique, Charleroi; E. Uytborck, secretary, Belgian Electrotechnical Committee; M. Colson, general director, Electrical Section, Belgian State Railways; C. Baron Forgeur, director at head office, ministry of Industry; a representative of the Societe financiers de Transports.

Czechoslovakia—Prof. V. List, chairman, Czechoslovakian Electrotechnical Committee.

France—J. J. Frick, Societe Alsacienne; E. Roth, Societe Alsacienne; M. Genissieu, Ministry of Public Works.

Germany—Dr. P. Schirp, secretary, German Electrotechnical Committee; Prof. Dr. Rudenberg, Siemens-Schuckertwerke; Prof. Dr. P. Strecker, president, German Electrotechnical Committee, Professor at Heidelberg; Dr. L. Fleischmann, Allgemeine Elektricitas Gesellschaft; Prof. Dr. M. Kloss, Professor at Charlottenberg; Dr. Rich. Stern, Allgemeine Elektricitas Gesellschaft; Dr. Molderhauser, Markisches Elektrizitats-Verk.

Great Britain—Sir Richard Glazebrook, K. B. E., chairman, British National Committee; Sir Archibald Denny, Bart., chairman, British Engineering Standards Association; L. B. Atkinson, di ector, Cable Makers' Association; C. P. Sparks, representing Institution of Electrical Engineers; Sir George Sutton, Bart., chairman, Cable Makers' Association and W. T. Henley's Telegraph Wor'.s; S. T. Allen, Municipal Electrical Engineer, Wolverhampton; E. G. Batt, General Electric Co.; W. S. Burge, English Electric Co.; S. B. Donkin, Association of Consulting Engineers; Capt. P. Dunsheath, W. T. Henley's Telegraph Works; A. R. Everest, British Thomson-Houston Co.; J. P. Gregory, Brit'sh Thomson-Houston Co.; W. Lee, Silvertown Lubricants, Ltd.; Lt. Col. F. A. Cortez Leigh, representing the Railway Companies; Dr. A. C. Michie, representing the Electrical Research Association; R. B. Mitchell, municipal electrical engineer, Glasgow, and president Incorporated Municipal Electrical Association; A. P. Mossay, Electric Vehicle Committee of the U. K.; W. Pearson, Brush Electric Engineering Co.; J. S. Peck, Metropolitan Vickers Electrical Co.; C. Rodgers, secretary, British Electrical & Allied Manufacturers' Association; T. Roles, municipal electrical engineer, Bradford; F. Wallis, English Electric Co.; P. Good, secretary of the British delegation; Lt. Col. K. Edgcumbe, Everitt Edgcumbe & Co.

Holland — Prof. C. Feldman, president, Dutch Electrotechnical Committee; Mr. Tromp, secretary, Dutch Electrotechnical Committee; Mr. Rosskopf; Bellaar Spruyt, chairman, Electricity Supply Companies Association; Prof. C. Van der Bilt; C. Pot.

Italy—C. Semenza, president, I.E.C.; Prof. E. Morelli, Professor of Electric Machinery Construction at the School of Engineering, Turin; Guido Ucelli, manager of Mechanical Construction, Riva Co.; Carlo Montu, Professor at the University of Naples; L. Lombardi, president, Italian Electrotechnical Committee; R. Vallauri, Professor of Electrict Traction at the Milan Technical School; Ernesto Perrero, Italian State Railways.

Norway—H. A. Mork, Ekebergbanen, Oslo.

Russia—Prof. M. Châtelain, chairman, Russian Electrotechnical Council.

Sweden—S. Norberg.

Switzerland — E. Huber-Stockar, president, Swiss Electrotechnical Committee; A. Huber-Ruf, engineer, Brown Boverie Co.; Charles Burlet, electrical engineer, Swiss Federal Railways; Antoine Schrafl, Swiss Federal Railways, construction and working; Dr. H. Zoelly, Escher-Wyss et Cie; Paul Thut, Bernese Power Works; Dr. Hans Max Schindler, Ateliers de Construction, Oerlikon.

Poland—C. Drewnowski, Ecole Polytechnique Warsaw; Z. Okoniewski, Polish Brown Boverie.

Spain—A. Artigas, Ministry of Public Instruction.

Plans to Relieve Power Shortage in Ontario

There is a move on foot in Ontario to relieve the threatened shortage of power in the northern part of the province, by transmitting electric energy developed on the Ottawa River, near the city of Ottawa, and about 200 miles east of Toronto. There are many potential power sites on the Ottawa River, which the government is planning to develop in the very near future.

The Hydro-Electric Power Commission has made provision in its estimates this year for a high voltage transmission line from Ottawa to Toronto, but no definite announcement has been made as to when this project will be undertaken. It has been estimated that at Chats Falls and other points on the Ottawa River, 250,000 hp. could be developed, as well as another 70,000 hp. on the Gatineau River, near Ottawa.

Baltimore Steam Plant To Be Operating This Fall

The Consolidated Gas & Electric Light & Power Co. of Baltimore, has in course of construction a new steam generating station which is being built in the southern part of the city on the site of an old plant. The station is called the Gould Street station. The initial installation of 47,000 hp. will be in operation by the fall of 1926 it is stated. The old building will contain the powdered fuel preparation equipment and the structure now under construction will house the turbines and boilers.

Muscle Shoals Committee Wants Beach as Expert

The Joint Congressional Committee on Muscle Shoals is apparently taking very literally the reference in its organic resolution to the Ford offer. It seems to be preparing to do all in its power to help bidders make their offers conform as nearly as possible to that tender.

The committee has announced its desire to employ Major General Lansing H. Beach, retired, the former Chief of Engineers, as a consulting expert. His appointment has not been made effective at the time of this writing, due to objections in the Senate to an appropriation which would make possible this expenditure.

The committee is holding daily sessions. Testimony has been taken from a number of government officials including the Judge Advocate General of the Army, Dr. F. G. Cottrell, the director of the Fixed Nitrogen Research Laboratory of the Department of Agriculture, Major Max Tyler, district engineer at Muscle Shoals, Dr. R. O. E. Davis and Dr. William H. Ross, of the Bureau of Soils. In addition, the committee has heard General Beach and J. W. Worthington. Colonel Worthington spoke on behalf of the American Cyanamide Co.

Formal notification that the joint committee is ready to receive bids was sent to Thomas W. Martin, of the Alabama Power Co.; E. F. Price, of the Union Carbide Co.; Henry Ford; W. B. Bell, of the American Cyanamide Co.; Elon H. Hooker; Frederick T. Hepburn; and C. E. Graff, of the American Nitrogen Products Co. An actual bid was received from F. E. Castleberry, of Shreveport, La. It was stated that he submitted the bid on behalf of clients, but declined to reveal who they are. A bid for nitrate plant No. 1 was received from J. H. Levering, of Washington, D. C.

It is not the purpose of the committee to make public the bids it will receive. It is recognized that the bidders probably will not name the maximum amount they are willing to give in the first offer submitted, but the committee expects to get the best possible offer from each of he bidders by informal personal negotiation. All of the safeguards of the Water Power Act will be thrown around any lease that is made, but because of the question as to the constitutionality of that act it will not be described as such in the lease.

Freight Rates on Anthracite May Be Increased

A round-table discussion was held by the Interstate Commerce Commission on March 16 with representatives of carriers which are proposing readjustments in freight rates on anthracite coal from Pennsylvania to northern New York territory, which generally would result in slight increases, and representatives of communities and other interests opposing the changes. No agreement was reached. As the new schedules are proposed to become effective April 1, the Commission must decide before that date whether it will suspend the new tariffs pending further investigation, or permit them to become operative and take up the matter subsequently in the form of complaints.

Supreme Court Will Consider Chicago Diversion Suit

A motion by the defendants to dismiss the suit of the states of Wisconsin, Ohio, Minnesota and Pennsylvania against Illinois and the Chicago Sanitary District was denied by the United States Supreme Court on March 22, pending arguments on the suit itself at a date which has not been fixed. The suit involves the authority of the Secretary of War to permit the Sanitary District to divert any water whatsoever from Lake Michigan, together with other questions raised in the Lake levels controversy. The motion to dismiss this suit was based on the ground that the Supreme Court, in the case decided last year, had determined the main questions now raised.

The decision of the United States Supreme Court refusing to dismiss the suit brought by Wisconsin and other Lake States to halt diversion by the Sanitary District of Chicago of 10,000 cu. sec. ft. from Lake Michigan is in no sense a defeat for Chicago, said George F. Barrett, special counsel for the Sanitary District, after hearing the decision.

"Neither is the decision a determination of the issues involved," he said. "The court indicated that it was not prepared to dispose of the issue as involved except upon a full hearing."

Flywheel Breaks, Cuts Light Wires and Causes Fire

A flywheel whirring at high speed in a pump house of the Nassau Gas Light Co., Kent Ave. and Rush St., Brooklyn, N. Y., broke on March 20. It cut electric wires and the resultant flash ignited gas. An explosion followed and flames shot high.

Twenty feet from the fire stood a huge gas tank filled to capacity. When Deputy Fire Chief, John F. O'Hara, responded to the alarm of a watchman he found the flames reaching perilously close to the tank. He turned in two more alarms.

When the small army of fire fighters were pouring streams on the burning pump station and were wetting down the blistering sides of the tank, a second explosion occurred. This was attributed to the ignition of a pocket of gas which had collected in the pump house. Its force was not as great as the first one, but it was sufficient to blast away part of the brick wall.

A representative of the Brooklyn Union Gas Co., which operates the plant, said:

> After an investigation we discovered that a flywheel attached to an exhauster engine broke and went through the roof, severing electric light lines. When the wires were cut there was a flash which ignited gas from the engine. The engine pumps gas into the main tank. This caused the explosion.
>
> We sent fifty men to repair the damage. The plant was back in operation at noon. A new engine was sent to replace the one destroyed by the explosion. None of our customers was deprived of gas by the accident. They were supplied by our five other plants.

British Government Expected To Accept Coal Plan

According to dispatches in the press the British government has decided to accept the Coal Commission Report, briefly covered in March 16 issue, *Power*, page 429, and to pass such legislation as may be required to give effect to its recommendations for reorganization of the coal industry. This announcement was made on March 24 by Prime Minister Baldwin to representatives of owners and miners who had been invited to meet him. The government, he said, had not reached this decision without careful consideration of the report and he indicated that acceptance of the recommendations required of the government the setting aside of certain preconceived notions.

It is believed to be the first time the British Government has ever agreed to adopt in full the recommendations of a Royal Commission on a major question of any character.

Neither the owners nor the miners were in a position at the time of the meeting to say what their action would be. But it was admitted by all sides that Mr. Baldwin, by his offer, had fulfilled the public expectations of his leadership.

If carried out, it involves the state in the expenditure of $500,000,000 to purchase coal royalties. It gives the state the sole ownership of future mineral rights. It introduces compulsory amalgamations within the industry where voluntary amalgamations are refused. It authorizes municipalities and counties to enter the retail coal trade. It makes profit-sharing compulsory.

It now remains to be seen first, whether the miners will pay the price in a temporary decrease in wages, to buy the complete guarantee of all the advantages for them that the report otherwise contains. And it is by no means a foregone conclusion that the owners will agree, for, aside from the wage reductions, the report is a condemnation of their management.

Either side would probably accept the report if only it was certain that its opponents were going to reject it.

The delicate question of continuing the coal subsidy was broached at the meeting at No. 10 Downing St. Mr. Baldwin announced that while the subsidy as such must be definitely ended April 30, he was willing to see that the coal industry got a limited amount of state help for three months as a loan, if both sides accepted the report before that date.

A.S.T.M. Working on High Temperature Specifications

Two new specifications for pipe flanges and fittings for high temperature service were discussed by a subcommittee of the American Society for Testing Materials, at a recent meeting in Providence. One of these dealt with forged or rolled steel pipe flanges and the other with lap-welded and seamless steel pipe.

Valmont Condensation Lake for Bird Sanctuary

A unique outgrowth of the new steam generating plant of the Public Service Co. of Colorado at Valmont, Colo., may be the creation of a game-bird sanctuary on the fresh water lake which provides water for condensation purposes. The proposal has come from Coloradians who are interested in the propagation and preservation of game life and has been received kindly by the officials of the company.

The lake, which has a present area of 120 acres and which will be enlarged eventually to 540 acres, is the only body of water of such size in the state that does not freeze over in the winter. It has been suggested that because its surface is always open, various wild fowl could be trained to make it their year-around residence and it would serve as an important preserve. If the company gives its approval, it is likely that experiments will be undertaken to ascertain whether the birds will remain there if given the opportunity.

Tests on the water show that it averages 45 deg. F. near the top and it does not get below 41 deg. at the bottom.

Byllesby Program Includes Increases in Power Plants

Projects now under way or soon to be started by the Standard Gas & Electric Co., according to H. W. Fuller, vice-president in charge of construction of the Byllesby Engineering and Management Corp., will include the $7,500,000 hydro-electric plant of the Louisville Hydro-Electric Co. at the Falls of the Ohio River which will have an initial capacity of 108,000 hp. in eight 13,500-hp. units, with provision for increasing the capacity to 135,000 hp. Power from this development which is to be completed not later than early in 1929, will be distributed primarily in Louisville by the Louisville Gas & Electric Co.

The new Bayside steam station which is being constructed by the Wisconsin Public Service Corp. at Green Bay, Wis., will have an initial installation of two 13,500-hp. units and three 13,000-sq.ft. boilers. The plant is expected to be ready for operation by January, 1927.

At the Horseshoe Lake plant of the Oklahoma Gas & Electric Co. a new 26,500-hp. turbine will be installed, together with a 10,000-sq.ft. boiler and necessary auxiliary equipment.

The San Diego Consolidated Gas & Electric Co. will increase its capacity by the installation of one 20,000-hp. turbine and one 11,000-sq.ft. boiler in addition to the rebuilding one of the rebuilding one of the present 11,000-sq.ft. boilers to increase its capacity and efficiency.

Fuel Technology Institute Formed in England

At a well attended meeting held in London on March 5, the British engineering fraternity considered the desirability of forming an Institution with a wide basis of membership to deal with fuel in all its aspects, according to *Engineering*.

Sir William Larke, Director of the National Federation of Iron and Steel Manufacturers, occupied the chair, and in his opening remarks emphasized the fact that none of the existing Institutions was able to deal with the question of fuel supply and utilization as fully as the importance of the subject demanded, and, moreover all papers upon it, were not as accessible as they might be to the specialists concerned, and still less so to the general fuel consuming interests.

Sir Philip Dawson, in moving the first resolution, dwelt upon the high percentage in production costs in most industries represented by the fuel bill, and illustrated this point by a reference to a recent conversation he had had with the managing director of one of the large German iron and steel works. In this establishement they had, by a study of the scientific control of fuel, reduced the production cost of steel by three shillings per ton.

Sir Richard Redmayne seconded the motion and expressed his confidence that a revival of industry, including that of coal mining, would ultimately result from more efficient methods of using fuel, if only by reason of the consequent reduced price, while Admiral Sir Edmund Slade in supporting these speakers, compared the importance of developing fuel supplies with food supplies, and urged the desirability of conserving native sources by scientific use.

The resolution put was as follows: "That this meeting is of opinion that in view of the national importance of the scientific utilization of fuel an Institution should be formed, having for its general objects, the promotion of the efficient production and utilization of fuel, and the co-ordination of work in this country and abroad associated with the scientific utilization of fuel in industry." This was carried unanimously, and after a considerable amount of discussion on matters of procedure and detail, a further resolution was put to the meeting, namely, "That an Organizing Committee be, and is hereby elected, to determine the general basis of organization and to define more specifically the object of the work of the Institution. Such Organizing Committee in the first instance to be representative of the following interests: academic, consulting fuel technologists, electrical, mechanical, oil, low temperature carbonization, and gas engineers, coal owners, iron and steel manufacturers and manufacturers of fuel equipment, in the proportion of not more than two members from each. The committee to elect its own chairman and to have power to choose additional members, but not exceeding in number one-third of the appointed committee, to assist in their deliberations." This was also carried unanimously.

The names of the committee as elected are Sir William Larke, Sir Philip Dawson, Sir Richard Redmayne, Admiral Sir Edmund Slade, Professor R. V. Wheeler, Dr. R. Lessing, Dr. W. M. Travers, F.R.S., and Messrs. David Brownlie, E C. Evans, S. McEwen, P. Rambley, L. C. Harvey, T. S. North, W. M. Selvey, and David Wilson. Also elected, subject to their willingness to serve, were Lord Montagu of Beaulieu, Evan Williams (President of the Mining Association) and C. F. Sparks.

A final resolution was put to the meeting and carried to the effect "That the Organizing Committee be requested to prepare a report as to the constitution of the Institution, and to make recommendations as to the name thereof."

In connection with the last two resolutions it was agreed by the meeting and those representatives of that body present, that the work of the Committee should include the consideration of amalgamation with the recently formed Institution of Fuel Economy Engineers. The report of the Organizing Comtee is to be circulated one month before the date of the next general meeting, which in any case is not to be later than July 31. The Hon. Secretary *pro tem.* is Edgar C. Evans, National Federation of Iron and Steel Manufacturers, Caxton House East, S.W.1.

Boiler Inspector Wanted by Government

The United State Civil Service Commission announces an open competitive examination for local and assistant inspector of boilers, applications for which will close on May 1. The vacancies are in the Steamboat Inspection Service and will carry salaries ranging from $2,700 to $3,600 a year. The examination will consist of letter-writing, arithmetic and questions relating to boilers, engines, motors, machinery of vessels, strength of boiler material and boiler inspection. Experience also is a ratable element. Information and application blanks may be obtained from the U. S. Civil Service Commission, Washington, D. C., or at examiners office at the post office or customhouse in any city.

New Type of Engineering Service Started

Edgar J. Kates has resigned as chief engineer of the oil engine department of the De La Vergne Machine Co., to open an office as consulting engineer specializing in the design and supervision of oil engine plants of all kinds.

Mr. Kates says that during his fifteen years' connection with the De La Vergne Machine Co. he came into close touch with the operating performance of hundreds of oil engine plants and became convinced that the performance of most plants could be greatly improved by a moderate amount of expert engineering supervision. This is true, he says, even though the operating force is entirely competent.

He plans by means of periodic inspections and the use of proper operating and maintenance logs to correct any faults in the engine plant layout, and to improve the operating and maintenance methods, so as to obtain maximum reliability and minimum costs. Mr. Kates is located at 203 West 13th St., New York City.

New John Ericsson Medal Will Be Awarded in May

The American Society of Swedish Engineers, 271 Hicks St., Brooklyn, N. Y., at its annual meeting in January established a medal which is to be known as the John Ericsson Medal, in honor of the Swedish engineer and scientist.

This medal will be awarded not oftener than every second year by the society to Americans of Swedish birth or descent or Swedish citizens as a recognition of distinguished accomplishments in science and engineering.

The medal is of gold and has on the face a portrait of John Ericsson surrounded by an inscription, "The American Society of Swedish Engineers—The John Ericsson Medal." The reverse, will have the emblem of the A.S.S.E. and a laurel wreath surrounding the name of the recipient and the year, "For Distinguished Achievements in Science and Engineering." The medal will be awarded for the first time in connection with the unveiling of the Ericsson national monument in Washington on May 29.

Personal Mention

Ralph Rainsford, formerly with the Duquesne Light Co., has joined the executive staff of the American Brown Boveri Electric Corp. as a consulting engineer.

Charles P. Wetherbee, well-known marine engineer, joined the engineering staff of the Westinghouse Electric & Manufacturing Co. on March 19, and will be located at the South Philadelphia Works.

William S. Johnston, formerly with Ford Bacon & Davis, Inc., is now with Stevens & Wood Inc., New York City. While with Ford, Bacon & Davis he was connected with the designing of the Sterlington Power station of the Louisiana Power Co.

Frank Walsh, formerly of Bellingham and Wenatchee, Wash., has been named superintendent of light and power of the Everett, Wash., district of the Puget Sound Power & Light Co. He fills the place vacated by **A. M. Chitty,** promoted to managership of the southwestern district of the company.

Obituary

James R. Anderson, the well-known representative of The Lunkenheimer Co., died on March 15. He became ill about two weeks before while en route from New Orleans to Little Rock and was taken to a hospital at Monroe, La. His condition improved and three or four days later he returned to his home in Cincinnati, where his death unexpectedly occurred. He was born in Scotland in 1864 coming to America when he was fifteen. In 1894 he became connected with The Lunkenheimer Co. and was located at New Orleans, later removing to Cincinnati. He is survived by his widow and two children.

Society Affairs

The Metropolitan Section of the A.S.M.E., will hold a meeting at 29 West 39th St., New York City, on April 18, to which all members of the four founder societies will be welcome. The subject for the evening will be "Combustion Problems."

The Hartford Section of the A.S.M.E. will hold a meeting on April 7 at the Hartford Electric Co.'s auditorium. G. E. Harcke, director of the Airco Davis Bourmobille Welding Inst., Jersey City, N. J., will speak on "Oxygen, The Wonder Worker." A motion picture, demonstration of liquid oxygen and discussion on oxy-acetylene processes will be included in the evening's program.

Business Notes

The Homestead Valve Manufacturing Co., Inc., Homestead, Pa., announces the appointment of the Marine Specialty Co., 208 South Peters St., New Orleans, La., to act after April 1 as its representative in that district.

L. Copleston, Inc., New York City, for the past five years the New York representative of the Erie Ball Engine Co., Pittsburgh, Pa., severed connections with this firm on March 1. L. Copleston, Inc., will continue in the sales of engines as manufacturers' representative as before.

Harold E. Trent, manufacturer of electrical heating and temperature control appliances, 259 North Lawrence St., Philadelphia, Pa., has recently employed John V. Calhoun, formerly engineer of furnace construction with the Combustion Engineering Corp., New York City, as sales manager.

The Prat-Daniel Corp., manufacturers of the Thermix air preheater and the stream-line stack for induced draft, 101 Park Ave., New York City, announces that The Stephan Co., 7016 Euclid Ave., Cleveland, Ohio, of which Walter G. Stephan is president, will represent the corporation in the Cleveland district.

The Strong-Scott Manufacturing Co., Minneapolis, Minn., manufacturers of the "Unipulvo System," powdered-coal combustion equipment for boilers, furnaces, brick kilns, etc., will be represented in the Chicago district by Geo. W. Heald with offices at 53 West Jackson Blvd., Chicago, Ill.

The American Brown Boveri Electric Corp., 165 Broadway, New York City, has recently added to its personnel Earl G. Hines, formerly with the *Electrical World*, as its general sales manager and L. J. Galbreath, recently in the advertising and sales department of the Bridgeport Brass Co., Bridgeport, Conn., to take charge of the publicity and sales promotion and as assistant to Mr. Hines.

S. C. Bloom & Co., frigeration and air conditioning equipment manufacturers, engineers and contractors, 53 West Jackson St., Chicago, Ill., announce the acquiring of the Webster Brine Spray and the brine spray refrigeration and packing house air conditioning business formerly handled by the Atmospheric Conditioning Corp. This is a new firm to be run by S. C. Bloom, formerly vice-president and western manager of the Atmospheric Conditioning Corp. These changes are the outgrowth of the purchase of the Atmospheric Conditioning Corp. by the Carrier Engineering Corp., Newark, N. J., with which it has been merged.

Goulds Pumps, Inc., Seneca Falls, N. Y., is the new name chosen by the Goulds Manufacturing Co. The company was incorporated in 1869 and then manufactured a wide variety of products. Today it manufactures pumps only so decided to change the name of the firm to conform more nearly to its business. This change is effective April 1.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Providence, R. I., May 3-6. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

International Electrotechnical Commission. F. V. Magalhees, 708 Fifth Ave., New York City. Meeting at 29 West 39 St., New York City, April 13-22.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Kansas State Association.** H. S. Dukes, School for the Blind, Kansas City, Mo. Convention at Abilene, Kans., May 19-21; **New England States Association.** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Minnesota State Association.** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio. National Board meeting at Chicago, Ill., May 3-5.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from May 31 to Dec. 1.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Mar. 22 1926
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	1.68
Clearfield	Boston	1.85@ 2.25
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.40@ 1.70
Hocking	Columbus	1.35@ 1.70
Pittsburgh	Pittsburgh	2.00
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.10@ 2.35
West Ky.	Louisville	1.15@ 1.50
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	2.75@ 3.50
Buckwheat No. 1.	Philadelphia	3.00@ 3.50
Birdseye	New York	1.40@ 2.00

FUEL OIL

New York—Mar. 25, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Mar. 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.97½@$2 per bbl.; 26@28 deg., $1.97½@$2.05 per bbl.; 28@30 deg., $2.02½@$2.10 per bbl.; 30@32 deg., $2.07½@$2.15 per bbl.; 32@36 deg., gas oil, 5.65c. per gal.; 38@40 deg., 6.2c. per gal.

Pittsburgh—Mar. 16, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Mar. 20, f.o.b. local refinery 26@30 deg., $1.55 per bbl.

Philadelphia—Mar. 18, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—Mar. 22, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Mar. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.25 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.50.

Boston—Mar. 22, tank car lots, f.o.b.; 12@14 deg. Baumé, 4.45c. per gal.; 28@32, deg., 6c. per gal.

New Plant Construction

Ark., El Dorado—Terry Dairy Co., W. Terry, Pres., 18th and Scott St., Little Rock, is having plans prepared for the construction of an ice plant, 25 ton daily capacity at Rock Island R.R. here. Estimated cost $40,000. Private plans.

Calif., Beverly Hills—W. G. McCarty, Los Angeles, is having plans prepared for the construction of an 8 story apartment including steam heating system on Wilshire Blvd. Estimated cost $1,500,000. Walker & Eisen, 701 Great Republic Life Bldg., Los Angeles, are architects.

Calif., Fresno—Syndicate, c/o A. Braverman, Griffith-McKenzie Bldg., plans the construction of a hotel on Orchard Hill. Estimated cost $500,000.

Calif., San Mateo—Syndicate, c/o M. A. McCann, 26 Montgomery St., San Francisco, is having plans prepared for the construction of a 5 story hotel on Alameda Drive. Estimated cost $1,500,000. C. H. Barrett, c/o owners, is architect.

Calif., Stockton—Pacific Telephone & Telegraph Co., Telephone Bldg., San Francisco, plans the construction of an office and exchange building at Lindsay and San Joaquin Sts. here. Estimated cost $1,500,000. E. V. Cobby, 444 Bush St., San Francisco, is architect.

Fla., Miami—Model Land Co., J. W. Hoffman, V. Pres., c/o Schultze & Weaver, 17 East 49th St., New York, N. Y., Archts., is having plans prepared for the construction of a 12 story bank and office building on S. E. First St., here.

Fla., New Port Richey — Burns-Becker Realty Co., W. E. Burns, Pres., will receive bids until April 6 for the construction of a pump house, 11,000 ft. water mains, etc. Estimated cost $25,000.

Ill., Chicago—H. Zisook, 1209 East 55th St., is having plans prepared for the construction of a 12 story apartment at 5230-5244 Sheridan Road. Estimated cost $3,500,000. T. R. Bishop, 35 South Dearborn St., is architect.

Ill., Decatur—A. E. Staley Mfg. Co., E. A. Staley, Pres., plans the construction of a power plant. Estimated cost $500,000. Private plans.

Ill., Galesburg—City plans artificial lake for water supply including the construction of a purification plant, dam, pumps, etc. Estimated cost $1,000,000. A. L. Richey, City Hall, is engineer.

Ind., Elwood—G. I. Sellers & Sons Co., plans the installation of two 300 hp. water tube boilers, etc.

Ind., Richmond—Eastern Indiana Hospital for the Insane, L. F. Ross, Medical Supt., will receive bids until April 12 for furnishing and installing a new 250 kva. engine and generator unit, etc. Estimated cost $50,000. Snider & Rotz, 703 Merchants Bank Bldg., Indianapolis, are engineers.

Ind., Richmond—Joseph Hill Co., is having plans prepared for the construction of a boiler room including four 400 hp. boilers, pumps, air compressors, tanks, etc. Estimated cost $100,000. H. C. Carroll, 511 Traction Terminal Bldg., Indianapolis, is engineer.

Ia., Cedar Rapids—City, L. J. Storey, Clk., is having plans prepared for the construction of a sewage disposal plant, pumping station, etc.

Ia., Iowa City—State University, W. H. Gemmill, Secy., State House, Des Moines, awarded contract for the construction of a new power station and heating plant here to A. A. Alexander, 502 Frankel Bldg., Des Moines. $239,977.

Ia., Mason City—Peoples Gas & Electric Co., F. J. Hanlon, Pres. and Gen. Mgr., will build a power plant. Estimated cost $1,000,000. Work will be done by owner's forces. Contracts for 7,500 kw. turbine generator awarded to General Electric Co. and stokers to American Engineering Co.

Mass., Rutland Heights—U. S. Veterans Bureau, Room 791, Arlington Bldg., Washington, D. C., will receive bids until April 20 for furnishing and installing a complete refrigeration and ice making plant at U. S. Veterans Hospital, No. 89 here.

Mass., Worcester—American Steel & Wire Co., G. S. Marshall, Gen. Mgr., awarded contract for the construction of a steel mill to Morgan Construction Co., Gross St. Estimated cost $1,000,000. Electric motors will be required.

Mich., Detroit—C. H. Miles, Miles Theatre Bldg., State and Griswold Sts., is receiving bids on revised plans for the construction of a 16 story theatre, hotel and office building including steam heating equipment on West Adams Ave. P. R. Pereira, Lincoln Bldg., 333 State St., is architect.

Mo., Kansas City—G. H. McCanles, Victor Bldg., plans the construction of two 7 story hotel buildings including separate heating plant at Warner Plaza and Main St. Total estimated cost $1,000,000. R. F. Gornall, 3619 Broadway, is architect.

Mo., St. Louis—Bd. of Public Service, E. E. Wall, Dir., 208 City Hall, will receive bids until April 6 for the construction of brick settings for four 460 hp. boilers at Bissell's Point pumping station. Estimated cost $15,000. This corrects report in March 16 issue.

N. Y., Brooklyn—American Sugar Refining Co., 51 South Second St., awarded contract for remodeling its sugar refinery including rebuilding of boiler house and rearrangement of electric generating equipment, etc. to Stone & Webster, 147 Milk St., Boston, Mass. New machinery will be installed.

N. Y., Brooklyn—J. F. James & Sons, 193 Montague St., is having plans prepared for the construction of a 13 story office building at 142 Joralemon St. N. E. Freehof, 135 East 43rd St., is architect.

N. Y., New York—A. Adelberg, 333 7th Ave., is having plans prepared for the construction of a 15 story hotel on Lexington Ave. Estimated cost $1,500,000. Schwarz & Gross, 347 5th Ave., are architects, Ball & Snyder, 505 5th Ave., are engineers.

N. Y., New York—Nacarsulmer & Lehlback, 507 5th Ave., Archts., are preparing plans for the construction of a 16 story office and loft building at Lexington Ave. and 26th St. Owner's name withheld.

N. Y., New York—S. Rosenberg Corp., c/o Gronenberg & Leuchtag, Bricken Bldg., Broadway and 38th St., Archts., plans the construction of a 15 story apartment on East 81st St. Work will be done by separate contracts under the owner's supervision.

N. Y., Rome—Supt. of Purchase, Capitol, Albany, will receive bids until April 8 for addition to power house for State School for Mental Defectives here.

N. C., Highlands—The town has made application to the Federal Power Commission for permit to construct a hydro-electric power development including power house, dam, surge tank, etc., on the Cullasagee River. The power will be used for street lighting and public utilities.

N. C., Knollwood (mail Aberdeen)—Mid-South Hotel Corp., Southern Pines, plans the construction of a 200 room hotel on Midlands Road here. Estimated cost $1,000,000. R. Page, Aberdeen, is interested.

N. C., Raleigh—Carolina Power & Light Co., P. A. Tillery, V. Pres. and Gen. Mgr., plans extensive developments including new sub-stations, etc. in North and South Carolina.

O., Cleveland—Paul Bros., c/o G. J. Paul, Fidelity Mortgage Bldg., is having preliminary plans prepared for the construction of a 10 story hotel at East 6th St. and Superior Ave. Estimated cost $1,000,000. G. Ebeling, 737 Prospect Ave., is architect.

O., Cleveland—The Wallace Realty Co., c/o Mr. Dunning, 441 Engineers Bldg., is in the market for three or four 60 hp. gas engines, etc.

Okla., Hugo—Oklahoma Power Co., P. J. Hayes, Purch. Agt., is in the market for a 1,000 kw. steam turbine generator unit for electric generating plant.

Pa., Pittsburgh — Fifth Avenue Apartment Corp., c/o P. Julian, 823 15th St. N. W., Washington, D. C., Archt., awarded contract for the construction of a 9 story apartment, here, to Boyle-Robertson Construction Co., 16th and Howard Sts., Washington, D. C. Estimated cost $1,500,000.

Pa., Union—West End Power Co., Pittsburgh, awarded contract for the construction of a hydro-electric power development including power plant on Cheat River, here, to Sanderson & Porter, 52 Williams St., New York, N. Y. Estimated cost $6,000,000.

Tenn., Knoxville—Rose Lumber Co., plans the construction of a power plant in connection with proposed new lumber plant. Estimated cost $250,000.

Tenn., Lexington—City Ice & Coal Co., recently incorporated, capital $20,000, plans the construction of an ice and cold storage plant.

Tex., Cotulla—City plans improvements to waterworks including new distribution system, pumping equipment, etc. Estimated cost $75,000. Engineer not selected.

Tex., Gonzales—Texas Central Power Co., Frost Bldg., San Antonio, awarded contract for the construction of a 40 ton ice and cold storage plant here to L. E. Meyer, Chicago, Ill. $128,000.

Tex., San Antonio—St. Anthony Hotel, W. N. Robinson, Mgr., Navarro St., plans the construction of a 12 story addition to present 8 story hotel at Travis and Navarro Sts. Estimated cost $1,600,000. A. B. and R. M. Ayres, Bedell Bldg., are architects.

Virginia — Roanoke River Power Co., Richmond, has been granted permit by the Federal Power Commission to construct a hydro-electric power development including power plant on the Roanoke River at Buggs Island for public utility service in Virgina and North Carolina.

Wash., Kelso—City has been granted permit to appropriate 30 cu.ft. of water from the Cowlitz River for water supply. Estimated cost $3,000,000.

Wis., Madison—Methodist Hospital, 303 West Washington Ave., is having plans prepared for the construction of a 6 story hospital including steam heating system. Estimated cost $500,000. J. R. & E. J. Law, First Central Bldg., are architects.

Wis., Milwaukee—Meyer Ice Co., 885 30th St., awarded contract for the construction of an ice manufacturing plant, to K. W. Construction Co., 589 Mabbett Ave. Estimated cost $40,000.

B. C., Vancouver—Georgia Hotel Ltd., c/o R. T. Garrow, 703 Yorkshire Bldg., Archt., had plans for the construction of a 12 story hotel including vacuum steam heating system with three 100 hp. high pressure tubular boilers. Estimated cost $2,500,000.

Ont., Belle River—Village, M. Forget, Clk., will receive bids until April 6 for 3 stage electric centrifugal pumps, filters, controllers, etc., for waterworks. Estimated cost $20,000. A. W. Connor & Co., Metropolitan Bldg., Toronto, are engineers.

Ont., London — Utilities Commission, plans the installation of two new switches and additional transformers, remodel and enlarge power control equipment for hydro-electric sub-station. Estimated cost $25,000. E. V. Buchanan, c/o owner, is engineer.

Ont., Ottawa—Dept. of Public Works, is receiving bids for motor generator sets for public buildings at Montreal, Que. Estimated cost $20,000.

Ont., Thamesford — Village, is having plans prepared for the construction of waterworks and distribution systems including pumps, reservoir or tank, etc. Estimated cost $25,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

Que., Coaticook—City awarded contract for the construction of a complete new power plant consisting of two 1,200 hp. waterwheel type generators to English Electric Co. of Canada Ltd., Hamilton, Ont.

Sash., Regina—Canadian Pacific Ry. Co., Montreal, Que., is having plans prepared for the construction of a hotel, here. Estimated cost $700,000. Ross & MacDonald, 1 Belmont St., Montreal, Que., are architects. J. M. R. Fairbairn, is chief engineer.

Australia, Melbourne—Victorian Government Railways, will receive bids until April 28 for supply and delivery of automatic switching equipment.